Natural Experiments in Swiss Economic History: French Annexation, German Professors and Hunting Regulations

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The Faculty of Business, Economics and Informatics of the University of Zurich hereby authorizes the printing of this dissertation, without indicating an opinion of the views expressed in the work.

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Chairman of the Doctoral Board: Prof. Dr. Steven Ongena

To my parents

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List of Abbreviations

AG	Canton Aargau
AI	Canton Appenzell Innerrhoden
AR	Canton Appenzell Ausserrhoden
BAFU	Bundesamt für Umwelt
BE	Canton Bern
BL	Canton Basel-Landschaft
BS	Canton Basel-Stadt
CH	Switzerland
DA	Duration of Annexation
DC	Duration of Codification
DBR	District-Based Regime
ETH	Eidgenössisch Technische Hochschule / Swiss Federal Institute of Technology
FA	French Annexation
FE	Fixed Effect
FR	Canton Fribourg
GE	Canton Geneva
GL	Canton Glarus
GR	Canton Graubünden
HD	Harvest Density
IV	Instrumental Variables
JFK	Jagd- und Fischereiverwalterkonferenz der Schweiz
JU	Canton Jura
LBR	License-Based Regime
LU	Canton Luzern
NE	Canton Neuchâtel
NW	Canton Nidwalden
OLS	Ordinary Least Squares
OW	Canton Obwalden
SD	Subject District
SE	Standard Error
SG	Canton St. Gallen
SH	Canton Schaffhausen
SO	Canton Solothurn
SZ	Canton Schwyz
TD	Time Dummy
TG	Canton Thurgau
TI	Canton Ticino

UR	Canton Uri
UZH	Universität Zürich / University of Zurich
VD	Canton Vaud
VS	Canton Valais
ZG	Canton Zug
ZH	Canton Zürich

Chapter 1

Introduction

Deepening our understanding of the Swiss historical experience and of the evolution of the local institutional context is one of the motivations for the applied econometric work presented here. This is, however, not necessarily the most important justification to study a seemingly disparate set of historical topics ranging from the heritage of French civil law in the 19th century, over the analysis of a xenophobic event and its repercussions for the two universities in Zurich at the end of the 19th century, to the long run effect of hunting regulation on game populations in the 20th century. The main ambition for conducting such a thesis was to combine unique Swiss data sets with empirical strategies of modern econometrics to make contributions to research questions of ongoing interest inside and outside of academia.

Taking a closer look at the three projects, some unifying elements can be highlighted: each of the three projects studies medium and long run effects of institutional changes or events that are notoriously hard to examine. Often the time dimension alone, e.g. studying phenomena that manifest over several decades, makes it virtually impossible to study such topics with experimental or more recent data. Moreover, other dimensions, like cross-sectional scope, ethical concerns or costliness preclude the application of experimental methods in some cases. These complications justify the choice to go back in history for data and, hopefully, some answers. Another unifying element is given by the use of Swiss data sources. This has been a pragmatic choice: the macro-political stability and territorial integrity of Switzerland combined with its diversity in institutional and

cultural dimensions and the finely grained administrative units provides rich data sets to be used for empirical work in economic history. The availability and access to such data is a comparative advantage of doing applied econometric work in this field at a Swiss university and justifies to choose research topics accordingly. Finally, each of the three projects aims to estimate effects that can be attributed to a difference in institutions (Chapter 2 and Chapter 4) or an event (Chapter 3).

All these projects, can be framed as *Natural Experiments of History*[1], that is, they exploit historical contingencies that feature an institutional change or a sudden political event which affects a part of the sample that can be compared to unaffected observations serving as a control group: a "controlled comparison" between "systems that are similar in many respects but that differ with respect to the factors whose influence one wishes to study" (Diamond and Robinson, 2010, p. 2). Of course, these historical events were most frequently not intended to be conducted as an experiment. Therefore, the extent to which the treatment was administered randomly has to be subjected to scrutiny and usually the treatment will not turn out to be as clearly random, as it would be in a designed experiment. This is a potentially significant weakness of the approach and a reason, why the method is mainly applied to shed light on topics which are hard to study in other ways, such as the topics at hand in this thesis:

Chapter 2 adds to a recent line of research on the long run effects of French reforms in occupied Europe during the 19th century. This research revolves around a contribution by Acemoğlu *et al.* (2011). Applying an instrumental variables (IV) approach, they show that the treatment of French institutional reform had a positive impact on economic development in the French-occupied part of Germany over a period of almost 100 years.

One contribution of this chapter lies in demonstrating, that the mechanism identified by Acemoğlu *et al.* (2011) and the claims of its generalisability pass a test of external validity in the Swiss context. The Swiss data set includes population data that goes back to 1798/1800 and measures the long run effects on economic outcomes using data from the end of the 19th Century. In the case of the German

[1] Refer to Diamond and Robinson (2010) for other examples and a more thorough introduction of the terminology.

data it is hard to disentangle the effect of extremely favorable geographical factors for the treated, that became extraordinarily beneficial during industrialisation (like coal and natural infrastructure), from the effect of institutions. The controlled comparison is between the annexed districts, which were endowed with French institutions, but returned to Switzerland after the Napoléonic era, and those that remained Swiss throughout.

Therefore, finding that geographically much less favored regions in Switzerland profited from French annexation is a striking and important result. Furthermore, this paper explores the respective contributions of institutional reforms at the level of private law as well as at the level of federal reorganization[2].

Chapter 3 adds to our understanding of how xenophobic events have affected expatriates living and working in Switzerland in the relatively distant past of the 19th Century. This research interest is related to current developments: in February 2014 the Swiss voted for a revision of the emigration policy from the EU to Switzerland. Although the details of implementation are not yet clear, the vote demands curbing immigration, which led to irritation among foreigners already working in Switzerland, for example, at the universities. In the aftermath of the vote, questions were raised how such an event could impact Swiss society in the next few years.

The medium and long term effects of this event remain to be observed and examined as history unfolds in the years to come. However, we can also go back in history to study the historical experience of Switzerland with large diasporas of foreigners in the past and how they reacted towards events in Switzerland, which they perceived as xenophobic at the time. We analyse an episode of Swiss history when two fledgling universities (University of Zurich (UZH) and the Swiss Federal Institute of Technology (ETH)) were heavily relying on foreign faculty, mostly from Germany. In 1871 the Germans living in Zurich were shocked by the *Tonhalle Krawall*, when a violent mob stormed the festivities by German expatriates after the foundation of the German Empire in 1871. Immediately this led to further unrest, violent clashes and to an exodus of German expatriates from Switzerland.

[2]Granting status as independent cantons and full members to regions previously dominated under the Ancien Régime.

The controlled comparison, in this case, is of comparing observations immediately before and after the treatment of the political event.

The *Tonhalle Riots*, for example, had a direct effect on the retention of faculty members and on the recruitment at the two universities in Zurich in subsequent years. Applying a proportional hazards model to a data set containing all full professors employed in Zurich from 1833-1913 the study sheds light on the Swiss historical experience with the dependence on foreign labor in the context of two universities in Zurich and explores the repercussions of a xenophobic event in the 19th century using qualitative and quantitative evidence.

Chapter 4 studies the differential effect of two different institutions of renewable resource management in the context of hunting in 20th century Switzerland. This study relates to the question of how to manage open-access resources that are prone to over-exploitation. In the literature, this phenomenon has been called the *Tragedy of the Commons* (Hardin, 1968). How can this topic be examined in the historical and institutional context of hunting in Switzerland? Swiss hunting regulations are marked by a pronounced dichotomy between the license-based regime (LBR) and the district-based regime (DBR). This is unusual in international comparison for such a small state and reflects the political independence of Swiss cantons.

The LBR is more of an open-access regime where hunting is free for all licensed hunters all across the canton and the DBR assigns private property rights to small groups of hunters over many years for a given district. The available Swiss data covers hunting statistics from 1933 to 2007. Two cantons (Luzern and St. Gallen) switch from the LBR to the DBR in the period of observation. Their development after treatment is compared to the control group, e.g. neighboring cantons. The institutional diversity for comparable habitat in close geographical proximity within the same framework of national legislation makes this data set salient in international comparison, because typically the observations are drawn from much more diverse backgrounds, and it is, therefore, particularly amenable for a quantitative analysis of the two types of institutions. Using the number of harvested animals as a proxy for long run population dynamics, this chapter presents an estimate of the long run effect of switching from the LBR to the DBR

in the case of Roe Deer.

The estimates confirm the prediction of higher stocks of game animals under the DBR based on institutional economics and the theory on renewable resources (Tietenberg and Lewis, 2012, p. 329). This class of problem is relatively widely studied for open-access fisheries and this paper adds to this literature. Undertaking such a study for game animals in the hunting context with the toolbox of modern panel data econometrics and estimating the functional form of the treatment effect of the common-property institution over time, are - to the best of my knowledge - novel contributions of this project.

Chapter 2

Long Run Effect of French Annexation on 19th Century Switzerland

2.1 Introduction

The economic literature on institutions and growth frequently and prominently argues that institutions matter for economic outcomes in the long run.[1] Nunn (2009) identifies institutions as a key determinant of economic outcomes in his survey of the empirical economic history literature. But, the author also emphasizes that institutional quality is only one factor besides culture, technology and geography. Moreover, Nunn observes, that the exact channels of causality are still poorly understood. Deaton (2010) makes the same point in his methodological survey article on instrumental variables (IV) and randomization in the context of development studies.

Nunn (2009) and Deaton (2010) both argue that we need to identify causal mechanisms that are generalisable. That is generalisable to different social, national and historical contexts. Acemoğlu *et al.* (2011) have proposed a research design, which they claim illustrates mechanisms for the Napoléonic era.[2] Working with German data, the authors have exploited the French-imposed institutional variations in order to estimate the causal effect of institutional reform on economic outcomes.

[1] See for example North and Thomas (1973) or Acemoğlu *et al.* (2001).

[2] In an earlier version of their 2011 contribution, they had included Switzerland as an observation for comparisons at the national level all over Western Europe (Acemoğlu *et al.*, 2009).

Specifically, they use the number of years of French administrative control as an instrument for the effect of institutions on economic outcomes. The quality of institutions is measured by a reform index consisting of a weighted average of the number of years a civil code has beem in effect, serfdom has been abolished, agrarian reforms have taken place and guilds have been abolished. Economic outcomes are measured by the urbanization rate and the share of industrial workers in the workforce. Their data is on district ($n = 64$) and province level ($n \leq 19$) with treated entities regionally concentrated on the left bank, of the Rhine and in Northwestern Germany. They find a positive effect of early institutional reform on economic outcomes.

At the time, the contemporary 19th century historian Friedrich Engels observed, that the French treatment brought not only good instititutions to Germany, but that the treatment was concentrated in a region characterized by natural resource abundance, access to the Rhine river and North Sea ports (Engels and Marx, 1960, p. 115-117)[3]. These observations by a contemporary analyst support the view, that French institutions have greatly benefited the treated regions in Germany. They also raise concern over geographic factors that might drive the results.

Of course, Acemoğlu *et al.* (2011) address this concern. The authors control, for example, for the presence of coal by dropping the coal producing county of Mark from the sample. This, however, may be insufficient, as the natural infrastructure of the Rhine and its tributaries makes coal readily available in virtually all annexed German territories. Moreover, they include panel data estimation techniques to rule out that geographic factors contribute to the effect they identify as being caused by institutions. A skeptic could hold that if the geographic factors - of coal being available at its source, as well as along the Rhine river and its tributaries - have a time-varying[4] effect on economic development,

[3]Refer to the Appendix for the full quotation. Note, how Engels emphasizes both the institutional and the geographical component in the economic development of the Rhineland. Moreover, he observed that the interaction, of both institutional and geographical factors, led to the salient economic and social development of the region.

[4]This is conceivable: coal became a much more valuable resource with the innovations of the industrial revolution than it was before. While the presence of coal is constant, its value is not. Neither is the degree of its exploitation (i.e. the seemingly constant geographical effect becomes time-varying in its effect on economic outcomes).

the geographical component driving the economic development of the German treatment region would become much harder to control for, even with panel data methods.

One contribution of this paper is to perform a test of external validity of this study with the Swiss data at hand[5]. If it fails to identify similar effects in the Swiss context, where like in the German case, many regions were forced to adopt French institutions, this would be an important caveat against overemphasizing the results from the research on Germany. If, however, the Swiss data - which is characterized by a treatment region favoured much less by such obvious geographical factors - yields similar findings as Acemoğlu *et al.* (2011), their claim of having identified a generalisable mechanism would gain credibility.

According to Nunn (2009), the research frontier has moved to unbundling institutions. A corresponding question that could be asked (and answered) in the Swiss context, concerns the respective contributions of the *Codification*[6] of private law and reforms at the Swiss federal level, which brought autonomy to formerly subjugated regions (*Untertanengebiete* or subject districts[7]) in the Napoléonic era.

Exploiting the finely grained Swiss district level ($n = 177$)[8] and by starting to unbundle the respective roles of two of the salient institutional changes in Switzerland at the time, both at the level of private law as well as at the federal level this paper makes a step forward in disentangling the effects of different institutional changes.

A second contribution is to relate these statistical findings to the historiographic literature on 19th century Switzerland. The results presented here are

[5]Note, that the research design for the Swiss data is only cross-sectional. The data availability is not sufficient for conducting a difference-in-difference strategy, as the first Swiss census data becomes only available for the time of the treatment.

[6]Here, codification refers to the comprehensive and coherent revision of private and commercial law in the 19th century. Frequently, this was a step away from Ancien Régime institutions and marked the legal foundation of a more modern, bourgeois society (Petrig Schuler, 2009).

[7]Subject districts are territories or political entities that were under the dominion of the full members of the old conferation. Cities in subject districts enjoyed more economic freedom and rights to political self-determination than the rural population, but in general the subject districts were dominated and their surplus was consumed by the more privileged members of the old confederation. These were mainly the city states and the *landsgemeinde* districts (rural districts, typically, of the inneralpine zone), that enjoyed considerable autonomy, quasi-democratic institutions and that enjoyed extra income from the territories they had subjugated in military conquests(Holenstein, 2013).

[8]Note, that many more districts are available as observations in a much smaller geographic area compared to the study on Germany by Acemoğlu *et al.* (2011).

mainly driven by the annexed districts in Northwestern Switzerland. Deaton (2010, p. 426) urges us to start asking why institutions had a positive impact in a given context instead of only answering whether they had such an impact at all. In a survey article about the industrial revolution in Switzerland, Fritzsche (1996, p. 126) writes, that in Swiss economic history the first half of the 19th century has been "more or less avoided" by researchers at the time. However, the annexed districts in Northwestern Switzerland are known for the watchmaking industry which developed after French occupation. Findings from Landes (2000) and Donzé (2009), which cover the development of this industry also at the time in question, can highlight possible mechanisms that explain why the estimated effect of early institutional reform turns out to be so large for the treated in the Swiss context.

The remainder of this paper is structured as follows: the data are presented in Section 2.2. Section 2.3 discusses the random treatment assumption and the applied IV methodology. Section 2.4 presents the results: French annexation is found to have a beneficial effects on population growth and the level of industrialisation in the second half of the 19th Century. Applying their IV research design, the generalised claims by Acemoğlu *et al.* (2011) pass this test of external validity and the contribution of institutional reforms at the federal level (early emancipation from subject district rule) is small and insignificant compared to the causal effect estimated for French annexation. Section 2.5 concludes.

2.2 Data

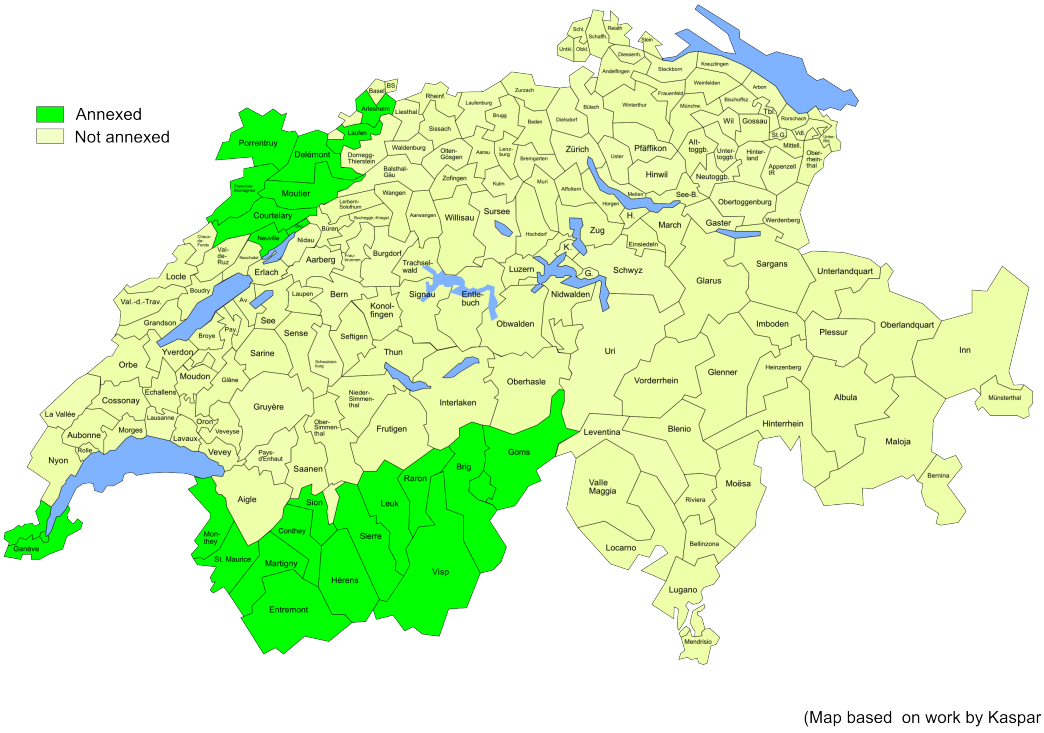
The cross-sectional data covers 177 Swiss districts[9] of which 23 were annexed by France (see Table 2.1).[10] The annexed districts are dispersed over geographically, demographically diverse regions and even across cantonal boundaries (see Table 2.1). They are, for example, characterized by varying shares of native German- and Frenchspeakers, protestants and catholics. Urbanized districts, like Geneva

[9]Because of data availability some districts were merged.

[10]The districts of the Canton of Neuchâtel were also annexed by Napoléon in 1806 and given to one of his marshalls as a fiefdom. The political and legal order of the Ancien Régime remained in place. For the purposes of this study, the Neuchâtel districts are not coded as annexed districts but as part of the control group.

and Biel, as well as rural districts are included in the annexed group. Except for Geneva and the landsgemeinde districts Brig, Goms, Herens, Leuk, Raron, Sierre, Sion and Visp, the annexed were all subject districts before French annexation.

Figure 2.1: Map of Annexed Swiss Districts



(Map based on work by Kaspar Staub)

Source: map based on unpublished work by Kaspar Staub.

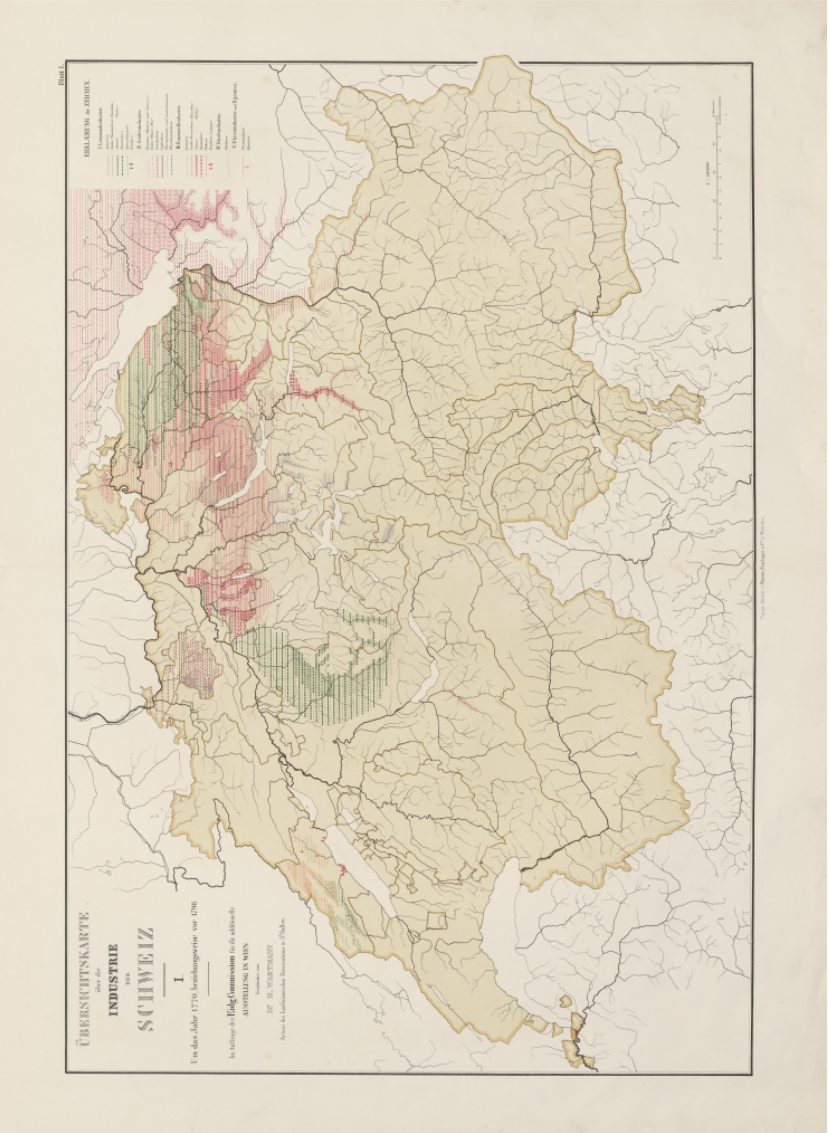
In order to proxy for the state of institutional reform the data set at hand includes:

- The number of years a district had been annexed by France in 1850 (source: Coing (1982, 1986) and various entries on cantonal history in the Historical Dictionary of Switzerland[11])
- The number of years a comprehensively codified civil law had been in effect in 1850 (source: Petrig Schuler (2009) and Coing (1982))

Figure 2.2 shows the spread of proto-industries in Switzerland for the period right before annexation from 1770 to 1795 (Wartmann, 1875)[12]. According to this

[11] `http://www.hls-dhs-dss.ch`
[12] Digitalisation of maps provided by ETH-Bibliothek Zürich, Karten

Figure 2.2: Map of Proto-Industries in Switzerland 1770-1795



map, watchmaking and other industries have not yet been established in the Nortwestern region before annexation. This region, however, drives the results in subsequent estimates. Compared to the rest of Switzerland the treated region was rather backwards before treatment. There is no reason to believe that the annexed districts were intentionally or unintentionally selected on the grounds of future growth prospects (see also Table 2.2).

The differences in development, culture and geography across districts can be controlled for by the following variables:

- The share of the district's population residing in cities that are larger than 5000 inhabitants in 1800 (source: Paul Bairoch (1988)) and the number of

Table 2.1: Overview over Annexed Group

District	Canton	Share of industrial workers	Duration of annexation	Duration of codification in 1850
Delemont	Bern/Jura	.56	21	46
Franchesmontagnes	Bern/Jura	.61	21	46
Porrentruy	Bern/Jura	.64	21	46
Courtelary	Bern	.82	21	46
Laufen	Bern	.60	21	46
Moutier	Bern	.69	21	46
Laneuville	Bern	.51	21	46
Arlesheim	Basellandschaft	.77	21	46
Biel	Bern	.96	16	46
Geneva	Geneva	.82	16	46
Brig	Valais	.58	4	0
Conthey	Valais	.15	4	0
Entremont	Valais	.14	4	0
Goms	Valais	.08	4	0
Herens	Valais	.07	4	0
Leuk	Valais	.10	4	0
Martigny	Valais	.21	4	0
Monthey	Valais	.37	4	0
Raron	Valais	.14	4	0
Saint Maurice	Valais	.34	4	0
Sierre	Valais	.11	4	0
Sion	Valais	.29	4	0
Visp	Valais	.09	4	0

monasteries in 1500 (source: Pfister (1964)) to control for the level of development before treatment

- The percentages of Protestants (census 1870) and native German speakers (census 1880) in the population (source: Swiss Census Data) to control for religious and cultural differences

- The altitude of the district capital and a full set of dummies covering different land use types are available to control for geographic factors (source: Swiss Census Data)

- The geographic distance of the district capital to Paris to control for proximity to the French capital (source of coordinates: Wikipedia)

- Dummies for subject districts control for the different roles the respective districts assumed within the Swiss confederation before French treatment. Districts are not coded as subject districts if they had more than 5000 inhabitants living in a city at some point in time before 1800 according to the Paul Bairoch (1988) city population data set, even if they were not full members of the old Swiss confederation. This is because large cities enjoyed

considerable freedom from subject district rule (source: Holenstein (2013))

- Dummies for the type of landuse in the early modern period. Default is land suitable for grain production. Dummies for mixed type of livestock with arable farming, for livestock farming and for landuse in the inner alpine zones are coded. The landuse zones control for geographic factors that influenced economic activity and institutions in the early modern period (source: Schluchter (2015))

Table 2.2: Descriptive Statistics of Independent Variables

	Subject Districts	Share Protestants 1870	Share Germanspeaking 1880	Monasteries 1500
Control	.76	.61	.71	.94
	[.43]	[.41]	[.41]	[1.48]
Annexed	.61	.20	.42	.65
	[.50]	[.33]	[.42]	[1.53]
All	.74	.55	.67	.90
	[.44]	[.42]	[.42]	[1.48]
	Population Density 1800	Urbanization 1800	Population Share above 1000m	Altitude District Capital
Control	73	.04	.09	.61
	[60]	[.14]	[.23]	[.22]
Annexed	42	.02	.25	.75
	[42]	[.11]	[.30]	[.29]
All	69	.04	.11	.63
	[59]	[.14]	[.25]	[.23]
	Mixed Landuse	Livestock Landuse	Inneralpine Landuse	Distance to Paris
Control	.08	.16	.12	482
	[.28]	[.37]	[.33]	[63]
Annexed	.22	.04	.57	450
	[.42]	[.21]	[.51]	[43]
All	.10	.15	.18	478
	[.30]	[.36]	[.39]	[62]

Notes: mean values, standard deviations in brackets

The measures used for economic outcomes deserve some further motivation. It has to be noted that the measures for economic activity such as output estimates or real wages are typically not at hand for the second half of the 19th century. The only official source for detailed district level data is population data given by the censuses. In the absence of more explicit data on economic outcomes the following measures are included:

- Like Acemoğlu *et al.* (2011) this paper uses the share of industrial workers in the overall workforce of the district as a measure of the level of industrialisation (source: Swiss Census Data)

- The annualized growth rate of industrial workers in the period 1870-1900

and of the overall population in the period 1850-1900 to measure the speed of development (source: Swiss Census Data).

Figure 2.3: Kernel Density Estimate of the Share of Industrial Workers in 1900

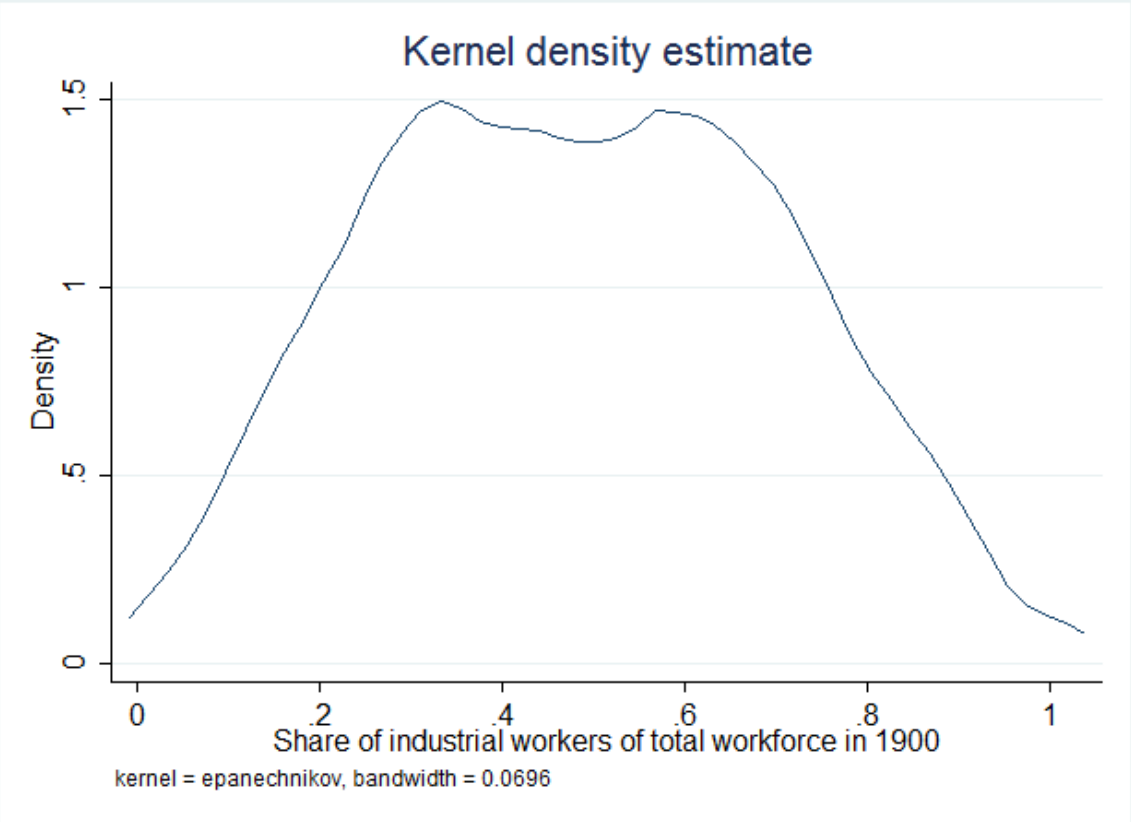


Figure 2.3 provides a Kernel density estimate of the share of industrial workers in 1900. The unconditional distribution of industrialisation levels shows that there is considerable heterogeneity among districts that demands explanation. With regard to the estimation technique - estimating a bounded dependent with ordinary least squares (OLS) - it is encouraging, that the mass of the observations lies in the middle of the bounded interval (Wooldridge, 2002, p. 661-663).

Table 2.3 reports the descriptive statistics for the post-treatment dependent variables. The descriptive statistics reported in Table 2.2 indicate that the annexed group does not differ much from the rest of the sample when it comes to the state of development before annexation (if at all, annexed districts are at a slight disadvantage).

Table 2.3: Descriptive Statistics of Dependent Variables

	% Ind. Workforce	Pop. Growth 1850-1900	Ind. Growth 1870-1900
Control	.50	.37	.71
	[.20]	[.57]	[1.30]
Annexed	.42	.86	1.87
	[.29]	[.71]	[2.15]
All	.49	.44	.87
	[.22]	[.61]	[1.49]

Notes: mean values, standard deviations in brackets

2.3 Methodology

The methodological approach of this study is two-pronged. The first prong is to treat French annexation of Swiss territory as randomly assigned (conditional on observables). If this holds, the OLS estimates reported in Tables 4.2, 2.5 and 2.6 have a causal interpretation of the effect of annexation[13] on economic outcomes (measured as population growth and the share of industrial workers in the workforce). The second prong is to take the IV research design established by Acemoğlu *et al.* (2011) and test its external validity in the Swiss context. Without taking a stand on their design, it is legitimate to take it to the Swiss data and to test their claim of having found a generalisable mechanism for the institutional change brought about by the French revolution. Their claim, however, passes this test. For the IV results, reported in Table 2.7, to hold, French annexation needs to be sufficiently correlated with the institutional change that is considered causal (strength of the instrument). Moreover, the instrument needs to be randomly assigned (conditional on observables) and to affect economic outcomes only through the identified institutional channel(s). Section 2.3.1 discusses the random treatment assumption and Section 2.3.2 the more exacting additional conditions for the validity of the IV estimator.

2.3.1 Random Treatment

The historical contingency of French annexation and early institutional reform of Switzerland at the beginning of the 19th century can be interpreted as a natural experiment. With the possible exception of Geneva, which had very close ties

[13] And emancipation from subject district status in the case of Table 2.6.

to France and the French revolution, France chose not to annex the economically most promising parts of Switzerland. The annexation depended either on diplomatic contingencies or military considerations: in the case of the Prince-Bishopric of Basel (in the Northwest of Switzerland)[14], France annexed these mostly rural districts because they were argued to be more closely associated with the Holy Roman Empire (which France had defeated in the War of the First Coalition) than with the Swiss confederation, which had remained neutral in the conflict. The Valais districts were annexed on military grounds to protect the lines of communications with French troops in Northern Italy. By fostering the revolution and its institutions in Switzerland, France aimed to create an ally that would secure its eastern border against Austrian influence(Grab, 2003, p. 112-122).

The emancipation of subject districts came about in three waves: in the first wave, annexed subject districts were immediately freed from all obligations to the old members of the confederation as they became proper parts of France. The second wave was a result of the Mediation Act in 1803, when some former subject districts were put on an equal footing with the incumbent members, as newly established cantons, e.g. the districts of Aargau, Ticino, Thurgau and Vaud, on the federal level (Grab, 2003). The third wave of emancipation came about when the city cantons granted freedom to their remaining hinterland in the context of the revolutionary uprisings around 1830. The first wave of emancipation can be taken as randomly selected on the basis of the argument made for random selection of annexation. The second wave of emancipation was by Napoléons decree for political motives equally exogenous to long run economic development. Even the revolutionary changes in 1830 probably still had a large element of randomness, even if more prosperous rural areas were more likely to successfully revolt and had higher incentives to push for institutional reform. All in all, however, these changes are taken as sufficiently random for the purposes of this test. Using the time structure of emancipation, a measure of early emancipation of subject districts has been constructed.[15]

Given the spatial structure of the Swiss and German data, it is noteworthy

[14]Note that distance to Paris is available as a control.

[15]The share of years, the district had been free, that is the number of years the former subject district has been free in 1850 divided by the maximum number of years.

that the annexed districts are lumped together in the case of Germany. Thus, it is possible that the annexed districts share certain characteristics with each other which distinguish them from the control group. For example through the presence of cultural, geographic factors or through proximity to trading partners. The annexed districts of Switzerland are more spread out, but the results are mostly driven by the Northwestern annexation region. As a consequence, the randomization assumption could be questioned if an unobserved confounding factor is suspected to have affected this region in particular.

2.3.2 Instrumental Variables

A thorough methodological review of the applied IV methodology is beyond the scope of this paper.[16] Deaton (2010, p. 426) points out, that "under ideal circumstances, randomized evaluations of projects are useful for obtaining a convincing estimate of the average effect of a program". The strength of the approach lies in the ability to recover estimates that are not biased by omitted variables or endogeneity bias (Angrist and Pischke, 2009).

The instrument (here, French annexation as a dummy or its duration in years) needs to be sufficiently correlated with the causal variable of interest (codification of private law). Instrument strength alone, however, is not enough to justify the use of annexation as an instrument. In order to be a valid instrument, the exclusion restriction has to hold as well. This requirement consists of two parts: the instrument needs to be randomly assigned with respect to the outcome and it has to affect outcomes only through the proposed causal mechanism (Angrist and Pischke, 2009, p. 117). This paper has argued that annexation can be thought of as randomly assigned in the given historical context. To argue that French annexation affects economic outcomes only through institutional changes is not as straightforward.

French annexation has changed institutions in Switzerland.[17] However, it did so by frequently changing a bundle of institutions at once. Therefore it is hard

[16]Such surveys exist: Deaton (2010) gives a critical review about the application of IV and randomization techniques in the context of development studies. More general reviews can be found in Angrist and Pischke (2009), Heckman and Urzua (2009) and Wooldridge (2002).

[17]See, for example, Coing (1982) or Acemoğlu and Robinson (2012, p. 289-294).

if not impossible to disentangle the precise effect of each institutional change. This paper takes the view, that the comprehensive codification of private law with economic freedoms and equality before the law is a main component of the institutional change that the French revolution brought to Ancien Régime territories. Change that is hard to disentangle from other institutional, cultural and social changes. In this sense, the identification of the causal mechanism is potentially blurry.

Moreover, the French came as invaders. They plundered and taxed Switzerland, they raised armies and garrisoned troops. On top of this, Switzerland became a theater of war.[18] This paper does not discern a regional pattern of such war effects that would be congruent with annexation. It would be problematic, for example, if the French spared the annexed territories from plundering or becoming a battleground. Still, the presented results can be meaningful, if such negative shocks have petered out by the end of the 19th century (as is suggested by the evidence presented in Table 4.2). Another complication could arise, if the annexed territories have profited from positive effects of French annexation, such as major infrastructure investments, which are known to have taken place in the Valais with the expansion of the road network around the Simplon pass.[19] In this regard it is noteworthy, that the results are not driven by the Valais districts.

Moreover, the French invaders may have brought not only changes in institutions as captured globally by the phenomenon of codification, but they may have changed local societies in another way that the literature argues to be meaningful for long run development in the 19th century - for example, the spirit of enlightenment which Mokyr (2010) highlights in his account of British development or bourgeois society that McCloskey (2011) proposes as the key driver of the modern world. If such changes coincided with French annexation, which they likely did, and played such an important role as argued by these authors, the presented IV estimates in Table 2.7 can be misleading because they would be confounding these effects with the effect of codification. Mokyr (2010, p. 261-268) mentions, for example, trade barriers as a major characteristic of Ancien Régime institutions

[18] See, for example, Maissen (2015) or Oechsli *et al.* (1922).
[19] See, for example, Maissen (2015) or Oechsli *et al.* (1922).

(besides the class and the guild system). This raises the issue, that French annexation may have changed custom regimes. Instead of legal changes, the causal effect of interest may have been access to the French markets during the time of annexation. If such views should be taken, given the random treatment assumption, the reduced form estimates would still be of interest as they highlight the role of French annexation for social change and economic development in 19th century Switzerland. But the respective contribution of the different causal mechanism linking French annexation to economic outcomes could not be determined and the IV estimates of the causal effect of codification would be confounded with other channels of causation.

The applied methodology is no cheap panacea. In particular, the defense of the assumptions of randomization and instrument validity themselves require a precise understanding of the underlying causal mechanisms and the historical context. Deaton (2010, p. 426-427) argues that it is often dubious whether estimates obtained from IV studies (which may well be internally valid in the local context of the sample) can be extended to the general case. In this light, checking the external validity of the Acemoğlu *et al.* (2011) research design with Swiss data and in other European contexts is a particularly worthwhile undertaking: because IV estimation does not necessarily yield generalisable results, it is important to test the predictions of landmark studies with additional data.

2.4 Results

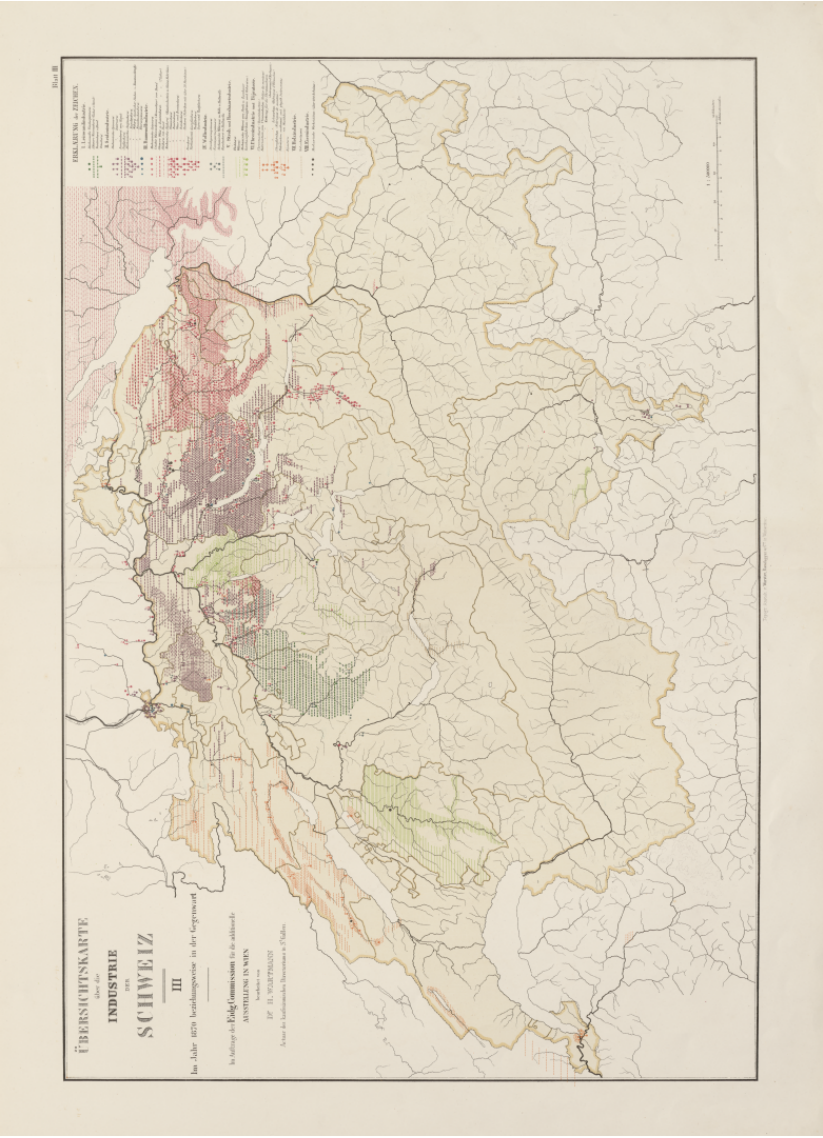
2.4.1 Causal Effects of French Annexation

The outcome of interest is economic development in the second half of the 19th century, when richer Swiss census data can be used. Figure 2.2 shows that proto-industrial clusters (for example, watchmaking and textiles) have not yet spread to the Northwestern treatment region before the treatment was applied. Figure 2.4 is from the same set of maps[20] but displays the spread of proto-industries in 1870 (around the time when the outcome variables of this study are measured). Note

[20] From (Wartmann, 1875).

that by now, the proto-industrial clusters have spread to the treatment region.

Figure 2.4: Map of Proto-Industries in Switzerland 1870



Using data for the second half of the 19th century has advantages: The first is to rule out that an immediate negative impact from annexation distorts the results. The second is that this is the period when we observe both economic outcomes and institutional diversity in the available Swiss data. Over the course of the 19th century there is variety in institutional quality: Codification projects are implemented canton by canton. Some cantons did not even codify until private law was homogenized at the federal level in Switzerland in 1912 (Coing, 1982, p. 1864-1866).

Exploratory regressions with population growth as an outcome variable have

the advantage that the outcome is available from 1800 to 1950 (with no data points between 1800 and 1850) and allow comparisons of the annexation effect in different periods. They yield a negative coefficient of annexation but a positive net effect for the annexed subject districts in the early 19th century. In terms of population growth, the subject districts have profited whereas the more privileged districts suffered from annexation. In the second half of the 19th century all annexed districts, regardless of being a subject district or not, experienced higher population growth. A treated (subject) district would grow 30 (47) per cent more over a period of 50 years compared to if it were not treated. In the early 20th century, when the institutional differences under consideration had largely converged, it no longer matters for population growth whether a district was once annexed by France (reported in Table 4.2).

This should not be interpreted as evidence that the treatment was necessarily beneficial: it could have been that growth in annexed districts was inhibited because of annexation or that, as the descriptive statistics suggest, the annexed districts were a little more backward in sociodemographic development at the outset and that we observe population levels catching up. This could lead to positive bias in the estimate. Since the research design is entirely cross-sectional, an economic outcome measure in levels would be useful to measure the long run effects of annexation. Nevertheless, this evidence is consistent with the hypothesis that it is the difference in institutions brought about by annexation that explains part of the heterogeneity in economic outcomes in the second half of the 19th century.

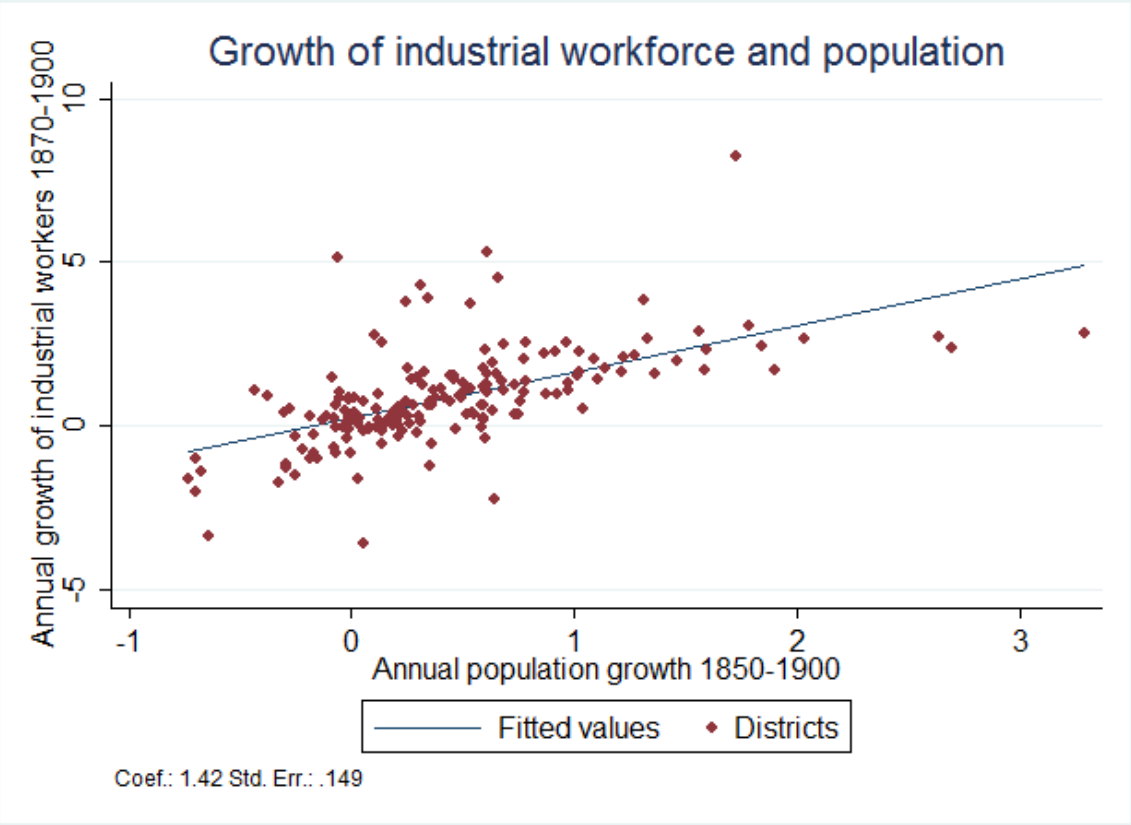
The other available outcome variable (in levels) is the share of industrial workers in the total workforce for the years 1870, 1880, 1888 and 1900. With regard to the results presented on population growth it is reassuring to note that population growth from 1850 to 1900 and growth of the industrial workforce from 1870 to 1900 are closely correlated (Figure 2.5). Compared to population growth rates, this outcome has the advantage of being a proxy for economic development in levels. A positive effect of treatment on industrialisation levels would remain informative even if the effect on the growth rate were largely driven by a catch-up process. A disadvantage of this variable is that it is not available for the time

Table 2.4: Population Growth and Annexation

	(1) 1800-1850	(2) 1850-1900	(3) 1900-1950
French Annexation (FA)	-0.170	0.527*	0.115
	(0.181)	(0.023)	(0.357)
Subject District (SD)	-0.0165	-0.372**	-0.263*
	(0.835)	(0.007)	(0.017)
FA-SD Interaction	0.285*	0.243	-0.000561
	(0.017)	(0.320)	(0.996)
Share Protestants 1870	0.0448	0.0579	-0.127
	(0.672)	(0.704)	(0.190)
Share Germanspeaking 1880	0.200**	-0.0765	0.358***
	(0.010)	(0.420)	(0.000)
Monasteries in 1500	0.0237	0.0640	0.0918**
	(0.345)	(0.154)	(0.003)
Population Density 1800	-0.00150**	0.00177	-0.000638
	(0.002)	(0.193)	(0.560)
Urbanization in 1800	0.528	0.814*	-0.141
	(0.118)	(0.015)	(0.646)
Altitude District capital	-0.505**	-0.139	-0.664**
	(0.001)	(0.627)	(0.004)
Mixed Landuse	-0.0406	0.0368	-0.0567
	(0.493)	(0.864)	(0.625)
Livestock Landuse	0.0134	-0.0914	-0.143
	(0.885)	(0.541)	(0.179)
Inneralpine Landuse	0.146	-0.311	0.159
	(0.132)	(0.167)	(0.444)
Distance to Paris	-0.00218**	0.000589	-0.000191
	(0.003)	(0.568)	(0.790)
Constant	1.944***	0.306	0.919*
	(0.000)	(0.584)	(0.049)
N	177	177	177

p-values in parentheses
SE are heteroskedasticity robust
and clustered by cantons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 2.5: Industrial Workforce and Population Growth



before 1870. The maps of industrial clusters from Wartmann (1875) suggest that the treatment region had hardly had any sign of proto-industrial development before the treatment (see also Figure 2.2). For the purposes of this paper it is the most telling economic outcome variable available.[21]

The regression outputs presented in Table 2.5 reveal, that the treatment effect of annexation on subject districts was positive, while the effect of annexation on non-subject districts is negative. The first column reports the effect of treatment as a dummy. According to this estimate, a treated subject district is about 20 per cent more industrialised compared to if it were not treated. The second estimate measures treatment as years of French annexation. Increasing the duration of treatment for a subject district by five years (one standard deviation) raises the level of industrialisation by about 7 per cent. It is striking that according to these estimates only the former subject districts profited in terms of industrialisation

[21]Note that the dependent variable is a fraction. In this case it could be more appropriate to use log-odds ratio of the fraction as the dependent variable. For details refer to Wooldridge (2002, p. 661-663). The qualitative results in this paper are robust to using the log-odds ratio of industrialisation as the dependent variable.

Table 2.5: Share of Industrial Workforce and Annexation

	(1)	(2) i
FA	-0.0452	
	(0.505)	
SD	-0.100*	-0.0654
	(0.017)	(0.106)
FA-SD Interaction	0.250**	
	(0.001)	
Duration of Annexation (DA)		-0.00311
		(0.674)
DA-SD Interaction		0.0144
		(0.069)
Share Protestants 1870	0.0316	0.0295
	(0.352)	(0.359)
Share Germanspeaking 1880	0.0618	0.0524
	(0.059)	(0.104)
Monasteries in 1500	-0.00207	-0.00297
	(0.831)	(0.773)
Population Density 1800	0.00104***	0.00106***
	(0.001)	(0.001)
Urbanization 1800	0.259*	0.324**
	(0.014)	(0.004)
Altitude District Capital	-0.00411	-0.0377
	(0.960)	(0.643)
Mixed Landuse	0.104	0.0938
	(0.100)	(0.148)
Livestock Landuse	-0.0846*	-0.0681
	(0.027)	(0.072)
Innteralpine Landuse	-0.297***	-0.243***
	(0.000)	(0.000)
Distance to Paris	0.000722*	0.000684**
	(0.011)	(0.009)
Constant	0.121	0.130
	(0.453)	(0.389)
N	177	177

p-values in parentheses
SE are heteroskedasticity robust and clustered by cantons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

levels from French treatment. The results are robust to using the shares of industrial workers from other years (1870, 1880, 1888, 1910), yielding coefficients of the same sign and same order of magnitude.

2.4.2 Subject Districts: French Annexation or Federal Autonomy?

The presented evidence highlights the positive effect of French annexation on subject districts. There is evidence that cities and landsgemeinde districts were affected differently by French annexation. Taking a closer look at subject districts only, two different mechanisms could drive the results. The subject districts could have profited from reforms in private law brought about by the French. Abolition of feudalism, freedom of occupational choice, marriage and to move as well as equality before the law culminated in the codification of the Code Civil. According to Acemoğlu *et al.* (2011) and Acemoğlu and Robinson (2012) these radical changes of private law institutions can be identified as the driver behind the superior economic development of treated regions in Germany, but should also have had an effect in Switzerland. Also, feudal relations between subject districts and their former masters were reorganized in the 19th century. This had an effect on land taxes and other transfers that were due to the more privileged members of the Swiss confederation, because the cantons had some souvereignty over deciding under which conditions a landowner could get rid of the Feudal payments (Schenkel, 1931).

Table 2.6 reports estimates for the subsample of former subject districts. The share of industrial workers is regressed on an annexation dummy or the duration of annexation as well as on the measure of early emancipation of former subject districts. In this statistical horse race, the measures of annexation outperform the measure of early emancipation. If random selection holds for both variables of interest, the estimates get a causal interpretation. The null hypothesis for early emancipation of former subject districts cannot be rejected for this specification. French annexation may have worked through an alternative channel.

Table 2.6: Share of Industrial Workforce and Early Emancipation

	(1)	(2)
FA	0.214***	
	(0.000)	
DA		0.0124***
		(0.000)
Early Emancipation of SD	-0.0163	-0.0289
	(0.802)	(0.660)
Share Protestants 1870	-0.000271	-0.00332
	(0.994)	(0.931)
Share Germanspeaking 1880	0.0553	0.0435
	(0.195)	(0.303)
Monasteries in 1500	0.0145	0.0157
	(0.306)	(0.261)
Population Density 1800	0.00235***	0.00245***
	(0.000)	(0.000)
Altitude of District Capital	0.131	0.115
	(0.292)	(0.353)
Mixed Landuse	0.0870	0.0709
	(0.195)	(0.299)
Livestock Landuse	-0.0263	-0.0230
	(0.602)	(0.634)
Inneralpine Landusee	-0.259***	-0.170*
	(0.001)	(0.011)
Distance to Paris	0.000429	0.000373
	(0.274)	(0.328)
Constant	0.00289	0.0457
	(0.989)	(0.829)
N	131	131

p-values in parentheses
SE are heteroskedasticity robust
and clustered by cantons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

2.4.3 IV - Testing the Acemoğlu *et al.* (2011) Design

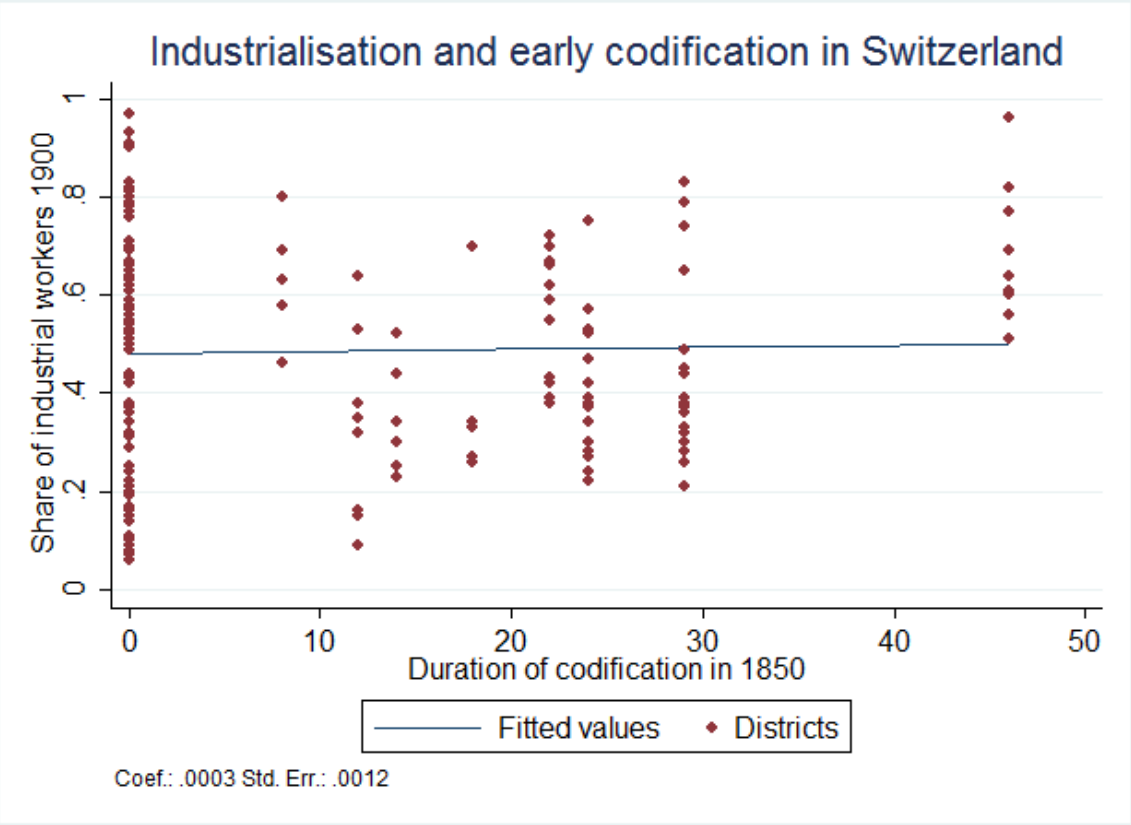
Codification of private law (and other changes in institutions) has been proposed by Acemoğlu *et al.* (2011) as the causal mechanism of interest. Furthermore, Acemoğlu and Robinson (2012, p. 289-294) maintain that Napoléon exported the French revolution not only to parts of Germany, but also to Italy, the Netherlands and Switzerland. Adapting the methodology proposed in Acemoğlu *et al.* (2011) to the Swiss context and data, this paper provides a test of whether the causal mechanism they identified for Germany helps to explain the Swiss data as well.

This is particularly interesting, because the German treatment region is comparatively well endowed with favorable geographical factors (natural resource abundance, good waterways and the proximity to North Sea harbours) which makes the exclusion restriction of their IV approach unlikely to hold. The Swiss treatment region, by comparison, is much less at an advantage over the rest of Switzerland. Indeed the summary statistics presented earlier indicate that the treated region is rather at a disadvantage.

What about key natural resources that could have promoted industrial development for the treated Swiss districts? Consulting the historiographic literature reveals, that at least initially, steel production on very modest scales existed in various parts of 19th century Switzerland, notably also in the annexed Northwestern region. A fledgling metalworking industry may have provided a first mover advantage to the favored locations (among them the treatment region), however, the maximum yearly production was only 13 700 tons at the end of the 1850ies in all of Switzerland. With the spread of the railroad network cheaper steel from abroad became available. Steel production shrank and by the 1880ies only one blast furnace was left (Fritzsche, 2001, p. 133). If the results of Acemoğlu *et al.* (2011) were driven only or mostly by geographic factors, it would be *ex ante* conceivable that an application of their research design to the Swiss context, that is relatively poor in natural resources (geographic factors) compared to the German treatment region, and not at an advantage, compared to the Swiss control, would fail to corroborate their findings.

At first glance, Figure 2.6 reveals that there is no clear correlation of early

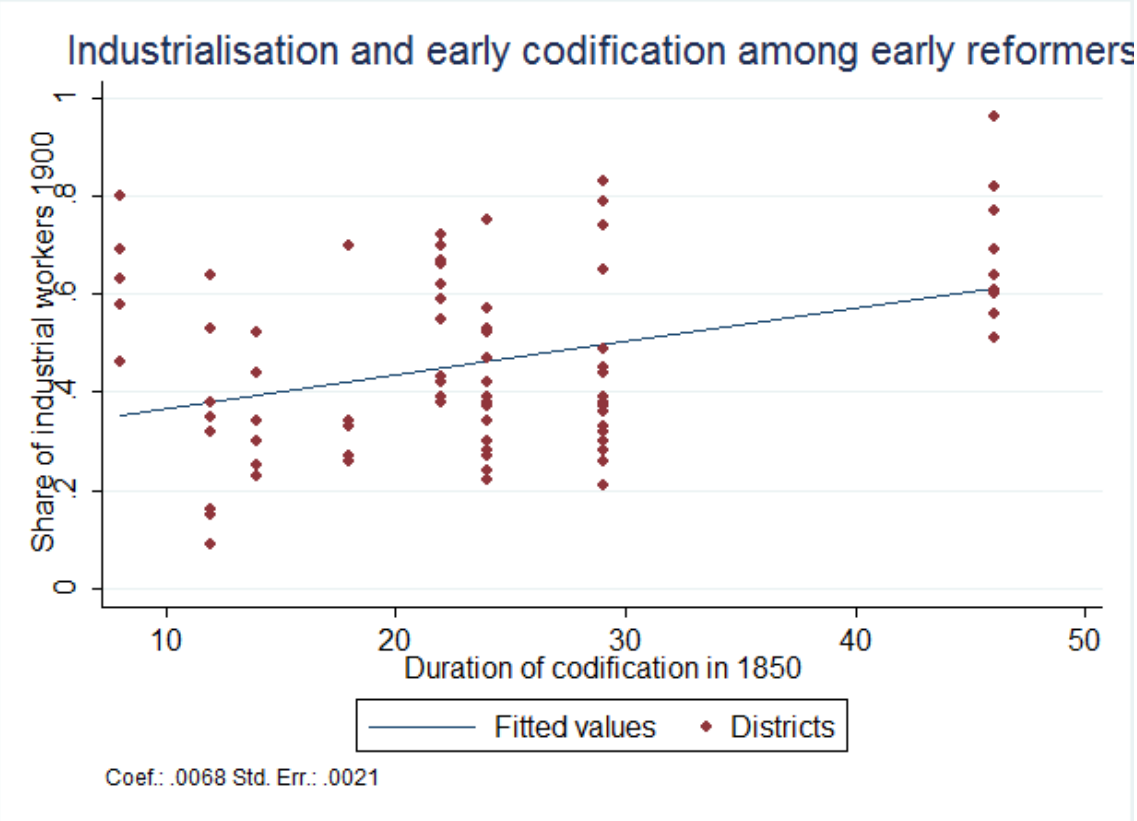
Figure 2.6: Codification not correlated with Industrialisation in the Sample



reform with industrialisation in the sample. Many districts that turn out to be highly industrialised in 1900 did not dispose of a comprehensively codified private law in 1850. Considering only the subsample of those that were either forced or chose to implement comprehensively codified private law before 1850, the relationship between early reform and industrialisation is clearly positive (Figure 2.7). From the point of view of the institutions hypothesis this observation is to be expected: institutional advance is correlated with economic development.

Many of the annexed districts were forced to adopt the Code Civil under French rule. After Napoléons defeat the reestablished elites of the Ancien Régime wanted to roll back institional reform. This was the case in the Northwestern annexation region which for the most part had come under the rule of Bern. The goverment of Bern appointed a commission of legal experts to deal with this task. Eventually this commission convinced the authorities of Bern that the Code Civil had worked so well during the last ten years that substituting it with the older Ancien Régime institutions would be irresponsible. Indeed, the Northwestern annexation region kept their French institutions even after the old law of Bern

Figure 2.7: Codification positively related with Industrialisation among early Reformers



was modernized itself. In the Northwestern annexation region the Code Civil was in force until in 1912 private law was homogenized at the federal level in Switzerland (Coing, 1982, p. 1864-1866). A similar development took place in Geneva, where with minor revisions the Code Civil continued to be effective until 1912. In Geneva as well, the legal experts had come to the conclusion that despite of the restaurative impetus of the time the Code Civil was the best of all available alternatives and that a reinstitution of Ancien Régime institutions would make no sense (Coing, 1982, p. 1866-1869).

The output presented in Table 2.7 suggests a strong reduced form relationship between industrialisation and the duration of annexation. The F-test for the excluded instrument yields a value of 22.49 for the first stage regression. This is a strong instrument. If the exclusion restriction holds, the coefficient of interest can be interpreted: one standard deviation of earlier codification raises industrialisation by approximately 14 per cent.[22] Thus, with the given research design as

[22]These results are robust to the exclusion of the two most urban districts among the treated (Biel and Geneva).

proposed by Acemoğlu *et al.* (2011), their claim of having found a generalisable effect cannot be rejected with the Swiss data at hand.

The Swiss data, however, differs from the data on Germany in terms of structure and available control variables. This makes it hard to compare the quantitative effects estimated here directly with each the estimates from Acemoğlu *et al.* (2011). Most closely related are the respective estimated effects of the duration of annexation on industrialisation levels on the district level. Multiplying the estimated effects by one standard deviation of the duration of annexation (Germany: ca. 6 years; Switzerland: ca. 5 years) yields an effect of 1.4 per cent in 1895 and 1.9 per cent in 1907 for Germany and 4.8 per cent in 1900 for Switzerland. The estimated effects for Switzerland are larger, but they are in the same order of magnitude for both studies. As opposed to Acemoğlu *et al.* (2009, 2011), this paper finds evidence for short run negative effects of annexation for districts that are not coded as subject districts (see Table 2.4 column 1).

The presented estimates can be interpreted as a series of tests for which the institutions hypothesis as formulated in Acemoğlu *et al.* (2011) and Acemoğlu and Robinson (2012) and their claim of having found a generalisable mechanism can fail. It is a striking and not necessarily expected result, that applying their methodology to Swiss data supports their findings for the German case, in which the annexed region is so strongly favored by geographic factors.

Furthermore, note that in the Swiss context, the results reported in Tables 4.2 and 2.5 have pointed to a possible complication: did treated subject districts profit from the reform of their private law institutions or rather because annexation freed them from being a subject district? Looking at subject districts only and controlling for the timing of emancipation from subject district status continues to produce a statistically and economically significant positive treatment effect from annexation. The hypothesis that the subject districts profited mainly from early emancipation of their status on the federal level is rejected.

Table 2.7: IV Estimates

	Reduced form	First stage	IV estimate
Duration Codification (DC)			0.010***
			[0.003]
			(0.000)
DA	0.010***	1.067***	
	[0.002]	[0.225]	
	(0.000)	(0.000)	
Early Emancipation of SD	-0.009	16.721**	-0.170
	[0.095]	[8.980]	[0.135]
	(0.925)	(0.075)	(0.208)
SD	-0.057	11.818**	-0.171*
	[0.062]	[5.757]	[0.096]
	(0.369)	(0.051)	(0.075)
Share Protestants 1870	0.035	6.231	-0.025
	[0.043]	[3.748]	[0.056]
	(0.427)	(0.109)	(0.655)
Share Germanspeaking 1880	0.050	-2.466	0.073
	[0.039]	[4.811]	[0.069]
	(0.218)	(0.613)	(0.285)
Monasteries in 1500	-0.004	1.942***	-0.023
	[0.013]	[0.671]	[0.015]
	(0.727)	(0.008)	(0.122)
Population Density 1800	0.001***	-0.019	0.001***
	[0.000]	[0.015]	[0.000]
	(0.004)	(0.224)	(0.001)
Urbanization 1800	0.324***	-15.832**	0.477***
	[0.109]	[7.258]	[0.147]
	(0.007)	(0.039)	(0.001)
Altitude District Capital	-0.047	9.789**	-0.142
	[0.142]	[4.033]	[0.149]
	(0.743)	(0.023)	(0.342)
Mixed Landuse	0.105	-3.944	0.143*
	[0.072]	[2.839]	[0.084]
	(0.160)	(0.178)	(0.087)
Livestock Landuse	-0.064	3.017	-0.093
	[0.044]	[3.637]	[0.061]
	(0.161)	(0.415)	(0.124)
Inneralpine Landuse	-0.251***	-7.566	-0.178*
	[0.071]	[8.088]	[0.104]
	(0.002)	(0.359)	(0.088)
Distance to Paris	0.001**	-0.084**	0.002***
	[0.000]	[0.033]	[0.001]
	(0.018)	(0.017)	(0.003)
Constant	0.098	23.959	-0.133
	[0.239]	[19.349]	[0.360]
	(0.685)	(0.228)	(0.711)
R-squared	0.537	0.693	0.270
N	177	177	177

Notes: * $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$
Heteroskedasticity robust standard errors in brackets
clustered according to cantonal boundaries
P-values in parentheses

2.4.4 Reference to the Historiographic Literature

It is noteworthy, that only subject districts profited from French annexation in terms of industrialisation levels. The reasons for this remain speculative, but the finding resonates with the historiographic literature (e.g. Maissen (2015)) which describes that the reaction to the French invaders differed across Switzerland. Whereas the French were hailed in the subject districts of Vaud as liberators, they met resistance from the privileged members of the old Swiss federation, be they city or landsgemeinde cantons.

This makes sense, as those latter entities profited from ruling and taxing the subject districts Schenkel (1931). In addition, it is possible that the cities and landsgemeinde districts already disposed of institutions that were of such quality as to empower their citizens sufficiently to engage in politics and profitable ventures, including commerce and early industries. Thus, the disruptive, negative effects of such radical reform may have outweighed the advantages from more "inclusive institutions" brought by the French revolution from the perspective of these more privileged or, possibly even, institutionally more advanced districts.

Subject districts appear to have profited from early reform in the spirit of the French revolution. However, industrial centers like Zürich and St. Gallen adopted equivalent codifications of private law only much later, without being visibly held back in development compared to other Swiss districts. Note also, that the Valais region - although annexed for four years - was not endowed with French civil law[23] and did not choose to adopt it until after 1850. Most of the annexed non-subject districts lie in this region. Therefore, the result that only subject districts profited from French annexation could be an artefact of the data structure: most non-subject districts in the annexed sample did not profit from French private law and were only shortly a part of France (landsgemeinde districts in the upper Valais). This could be potential evidence for codification (as opposed to other effects of annexation) driving the results on economic development. For those, however, who chose or were forced to adopt a comprehensively codified

[23]This is exceptional. All other European territories in Holland, Nortwestern Germany and the Hansa cities annexed in the last wave of French expansion in 1810 adopted the Code Civil (Coing, 1982, p. 1888).

private law before 1850 (the annexed districts were forced, but some other cantons adopted codified private law after the Napoléonic era), the earlier codification was associated with higher economic outcomes and the IV estimates, if the basic outlay of the research design by Acemoğlu *et al.* (2011) and its adaptation to the Swiss context is acceptable, point to a causal effect of codification (or more broadly speaking: change in the institutions of private law) on industrialisation for the treated.

The Northwestern annexation region is driving the results. These are the districts that did in fact experience the institutional changes of interest, as opposed to the annexed Valais, where the Code Civil was never instituted. After French annexation, the Swiss Northwest became known for the development of its watchmaking industry (and the spread of other industrial clusters, such as textiles). Findings in the historiographic literature dealing with the watchmaking industry are consistent with the hypothesis that better institutions led to more rapid industrialisation in the annexed districts. Landes (2000, p. 12) points out, that watchmaking as an industry is comparatively free from local constraints[24]: The raw materials used represent only a small fraction of total cost, the production process does not require large amounts of fuel or energy and the final product is easy to transport to distant consumers. Landes argues that because of this freedom, the watchmaking industry frequently moved its production into regions with a favorable institutional environment. Therefore, observing that the watchmaking industrial clusters have spread to the treated region as opposed to other neighboring regions that were not treated is telling (See Figures 2.2 and 2.4 in comparison).

This paper does not argue that the institutional reform brought about by French invaders triggered industrialisation in Switzerland. Indeed, the evidence from Wartman (1873) shows that proto-industries were already well established in Swiss districts under the Ancien Régime. However, when the watchmaking industry expanded in Switzerland during the 19th century it did so in a region that had been characterized by institutional change in the spirit of the French

[24]This freedom needs to be qualified. Donzé (2009, p. 39-40) observes that the watchmaking industry is characterized by industrial clusters. Thus, the Northwestern annexed districts are likely to have profited from their immediate proximity to the already established cluster in Neuchâtel.

revolution.

Donzé (2009, p. 15, 24) and Landes (2000, p. 230) argue that freedom from the guild system was one reason for the relocation of watchmaking artisans and the development of production clusters, in particular in Northwestern Switzerland.[25] Before the French revolution took hold in Geneva, some watchmakers relocated production to France were political institutions were more inclusive than in Geneva (Landes, 2000, p. 265). Whereas the rural regions in Switzerland were typically free from the guild system, the guilds were strong in towns and cities. In the Northwestern annexed districts even the towns and cities were free from guilds after annexation, allowing for rapid industrialisation in the cities as well. After annexation and the ensuing institutional changes, the Northwestern annexation districts provided a favorable institutional environment to the spread of industry. This paper does not make a stand as to how to quantify the respective contributions of freedom from the guild system in comparison with other institutional changes, such as the codification of private law.

2.5 Conclusion

This paper provides an out of sample test of the findings for Germany in Acemoğlu *et al.* (2011). It is a striking and not necessarily expected result, that the qualitative and quantitative results and the time structure of effects obtained for Germany can be replicated for the Swiss natural experiment. In this regard, the effect of French annexation could indeed be driven by a generalisable mechanism, through the institutional mechanism proposed by Acemoğlu *et al.* (2009, 2011); Acemoğlu and Robinson (2012). The instrument does not appear to be weak and the case for random assignment is comparatively strong for the Swiss data. The reduced form estimates highlight the role of French annexation in explaining the regional heterogeneity of industrialisation in the second half of 19th Century Switzerland. As such, this paper makes a contribution to the replication of landmark IV studies

[25] Landes (1999, p. 251-268) acknowledges the role of the French revolution in changing the institutional landscape of the Ancien Régime in Western Europe, but in his account of the Swiss watchmaking industry he does not mention French annexation of Northwestern Switzerland as the direct cause of beneficial institutions (Landes, 2000).

in the field of development and institutional economics, for which - even if they can be seen as having high internal validity - we do not know so much about their external validity.

To argue that annexation only worked through institutions, or even more precisely through the codification of private law, as a causal channel is harder. The historiographic literature, particularly on the watchmaking industry in the treatment region of Northwestern Switzerland, suggests several alternative mechanisms instead of codification (for example, the abolition of guilds, trade relations under French rule, changes in culture, etc.) that all seem plausible. With the data at hand it is not possible to quantify their respective contributions.

Beyond the test of external validity for Acemoğlu *et al.* (2011) and firmly establishing the causal effect of French annexation on economic outcomes, the Swiss data offer an opportunity to quantify the respective contributions of French annexation and the emancipation from subject district status. In a statistical horse race between the two, the institutional reforms at the federal level (emancipation from subject district status) are neither statistically nor economically significant. In this regard, this project has exploited an opportunity in the Swiss context to make a novel contribution towards the unbundling of different institutional changes in the Napoleonic era.

Chapter 3

German Professors and the 1871 *Tonhalle Riots* in Zurich

3.1 Introduction

After the Swiss vote on curbing immigration in February 2014 there was discussion of how this would affect the ability of Swiss employers, especially the universities, to attract and retain talent. In the aftermath of the vote, Antonio Loprieno, President of the Rectors' Conference of Swiss Universities, speculated that individuals sensitive to cultural phenomena would be heavily affected by the vote (NZZ, 11.02.2014). More recently, Kaspar Villiger, former Federal Councillor, worried that Switzerland is taking "enormous risks" of being no longer attractive to the foreign talent pool after the February 2014 vote (NZZ, 29.06.2015). Similarly, Sociologist Dirk Helbing at the Swiss Federal Institute of Technology (ETH) reasoned: "People will think twice about whether they want to do science in a country where foreigners feel they might not be fully welcome" (Nature, 506, Feb. 20, 2014, p. 277).[1]

It is still unclear how todays push and pull factors at Swiss universities and the relevant academic outside-options will affect Swiss research institutions in the medium and long run. However, academic institutions hinge critically on their ability to recruit and retain the best available talent. We turn to the 19th Century and examine the long run experience of the University of Zurich (UZH) and the ETH Zurich with foreign talent from 1833 to 1913 and how it changed over time.

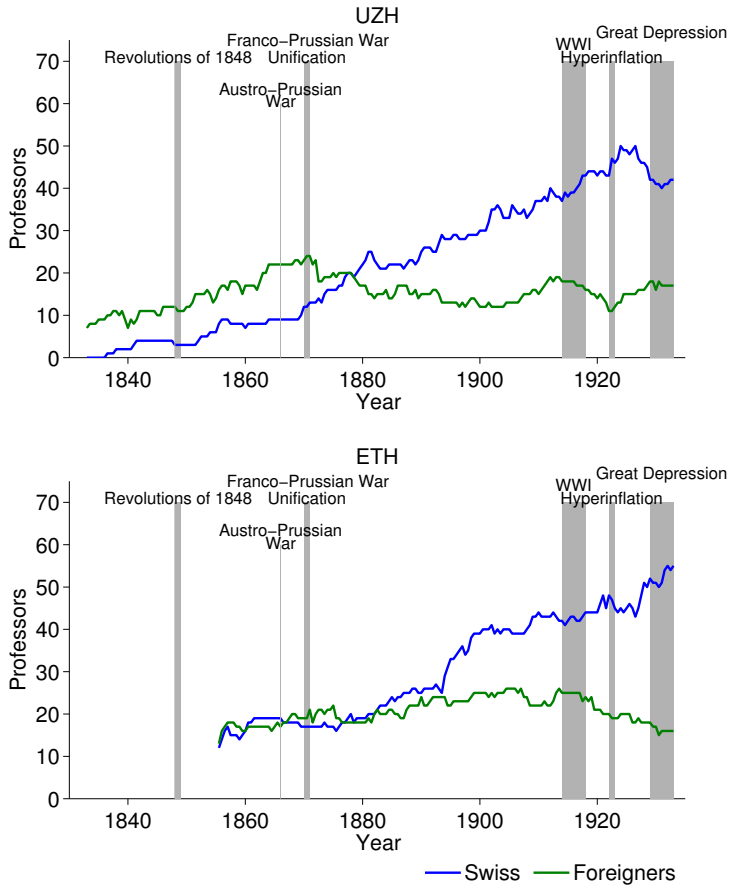
[1]There is also anecdotal evidence of academic personnel leaving Zurich (`www.thetimes.co.uk/tto/news/world/europe/article4011533.ece`).

We present quantitative and anecdotal evidence suggesting that it was affected by the political situation, both in Switzerland and abroad. For Continental Europe, this observation period can be divided into two phases: first until about 1870, a rather turbulent phase of (often failing) liberal revolutions, wars of national unification characterized by large real wage inequalities and, second, a relatively calm period, characterized by real income convergence (Williamson, 1995, p. 154-155). The historical experience shows that, despite paying low wages in international comparison, the two Swiss universities in Zurich profited greatly from an inflow of foreign talent in the first phase. We note that, initially, the faculty was of comparatively high quality, resembling the characteristics of German top-institutions at the time. However, although academic wages in Zurich started to catch up in the second phase and eventually gained an edge over German wages, it became more difficult to maintain the high quality composition of professors. Depending on the changing attractivity of the academic environment at the German-speaking universities outside Switzerland, which was the relevant alternative for the vast majority of the professors in Zurich, the composition of professors started to resemble that of an entry-level university in the German-speaking academic world.

Before Switzerland developed a larger talent pool of its own towards the end of the 19th century, a considerable share of full professors in Zurich were foreigners (Figure 3.1). From evidence such as the autobiographies of economists among the professors we learn that seeking and keeping employment at the newly-established institutions in Zurich, despite comparatively low salaries, was initially driven by political issues in the aftermath of the failed liberal revolutions in the German states. The ensuing wars of national unification established Prussian hegemony, which played a role for some professors to prefer staying in Zurich. However, it also led to anti-German sentiments in Zurich, which made it harder for the German expatriates to integrate themselves. The qualitative evidence points to the role of political events in the allocation of internationally mobile academic personnel and to the political orientation of German professors in Zurich at the time.

Studying the duration of individual employment spells and their changing attrition rates at the two Zurich institutions from their foundation until 1913 allows

Figure 3.1: Professors at Zurich, 1833-1933



Only full professors; data source: Erziehungsrat des Kantons Zürich (1938, p. 960-1001), Rektorat der Universität Zürich (1983, p. 665-748), Eidgenössische Technische Hochschule (1955, p. 226-254)

us to gain quantitative insights into the historical interactions of the real income differential and the timing of political events with respect to retaining foreign talent at the two universities in Zurich. We note that, initially, the faculty was of comparatively high quality despite the low income of professors in Zurich, resembling the characteristics of German top-institutions. However, although academic wages in Zurich started to catch up and eventually gained an edge over German wages, it became more difficult to maintain the high quality composition of professors. Depending on the changing attractivity of the academic environment at the German-speaking universities outside Switzerland, which was the relevant alternative for the vast majority of the professors in Zurich, the composition of professors started to resemble that of an entry-level university in the German-speaking academic world.

Using wage data from UZH, ETH and a suitable German reference university (Bonn), we are able to assess quantitatively the relative indifference of the German academics to income in their choice to stay in Zurich. Applying a proportional hazards model we show that employment spells were prolonged or shortened by political events. The quantitative evidence suggests that the hazard of a German professor leaving Zurich was unusually low at the time of the failed liberal revolution of 1848 in the German states and that a large share of German professors left Zurich immediately after the Franco-Prussian war. The latter phenomenon is not necessarily driven by nationalist excitement and the new academic opportunities in the German Empire at the end of the 19th century, but coincides with the *Tonhalle Riots* in Zurich: a progrom-like riot[2] against the festivities of German expatriates in Zurich[3] on the occasion of the unification of Germany after the successful war against France. The Germans at the Tonhalle experienced virtually no protection against a violent mob of locals and a group of French army officers who attacked the guests, including women, of the festivities until late into the night and as they fled, although the Zurich police forces were present observing the events.[4] The ensuing outrage among the German community led to violent fighting for four days until four batallions Swiss military subdued the unrest.[5] The qualitative evidence and the timing of German professors leaving Zurich immediately and shortly after these events suggests that at least part[6] of that loss was

[2]For this characterisation of the event refer to (Urner, 1976, p. 64): "Als sich die angestauten Spannungen im Zürcher Tonhallekrawall vom 9. März 1871 in einer progromartigen Stimmung gegen die Teilnehmer der deutschen Sieges- und Reichsgründungsfeier entluden, nahm der schweizerisch-deutsche Pressekonflikt die heftigsten Formen an."

[3]These festivities were initiated by Gottfried Semper, former liberal revolutionary of 1848 and founding father of ETH's architectural school, Otto Wesendonck, banker and philanthropist, Adolf Gusserow, former rektor of UZH and Adolf Exner, professor of law. These individuals represent the most accomplished members of the German expatriate community who were locally and internationally well-connected and had made substantial contributions to business, science and the arts in Zurich at the time (Urner, 1976).

[4]See Urner (1976, p. 211-212).

[5]As the violence escalated in protests against the conduct of the Zurich police and to free incarcerated Germans, five Germans were killed. Refer to de Weck (2013) for a short summary of the events. For a more thorough account of the events and its repercussions in Zurich and abroad refer to Urner (1976, p. 207-221).

[6]On the one hand, unification also implied a larger labour market for academics, with new universities founded, especially technical universities, which made the German university system more attractive for professors in Zurich. On the other hand, liberal or progressive Germans experienced the social climate in Germany as oppressive, see for example Sieveking [1935] (1977, p. 104).

directly caused by the anti-German sentiment which culminated in the *Tonhalle Riots*. Furthermore, we present quantitative evidence for the loss in attractivity of the universities in Zurich as employers of foreign talent in the following years. Our evidence suggests that the two universities suffered from this sudden loss of senior faculty members and struggled to find adequate replacements over the course of several years.

The remainder of this paper is structured as follows: the data on the professors at UZH and ETH and the data on income are presented in Section 3.2. Section 3.3 illustrates the survival analysis with a proportional hazards model. Section 3.4 presents our results on the characteristics of the professors employed in Zurich. Applying a proportional hazards model allows us to illustrate the attrition suffered among the German professors at UZH and ETH over time, particularly after the *Tonhalle Riots*, controlling for differences in wages, the different ability of UZH and ETH to retain talent, as well as for age. Section 3.5 concludes.

3.2 Data

3.2.1 Professors

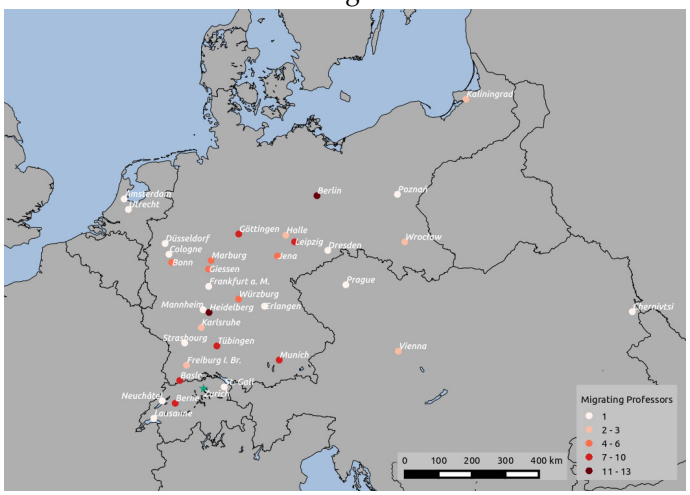
The data set on full professors appointed by the University of Zurich (UZH) in the period 1833-1933 contains 273 individuals.[7] The information on the professors is compiled from the short biographies in the two *Festschriften* for the 100 and the 150 years anniversaries of the University in 1933 and 1983 (Erziehungsrat des Kantons Zürich 1938, p. 960-1001, Rektorat der Universität Zürich 1983, p. 665-748). For the technical university (ETH), we have 249 full professors.[8] The observation period covers the years 1855-1933, the main source is the *Festschrift* for the 100 years anniversary of the ETH (Eidgenössische Technische Hochschule, 1955) and

[7] Among them are 12 economists: Bruno Hildebrand (1812-1878), Victor Böhmert (1829-1918), Julius Platter (1844-1923), August Sartorius von Waltershausen (1852-1938), Julius Wolf (1862-1937), Heinrich Herkner (1863-1932), Heinrich Sieveking (1871-1945), Joseph Eßlen (1879-1935), Werner Bleuler (1886-1928), Eugen Grossmann (1879-1963), Manuel Saitzew (1885-1951), and Richard Büchner (1899-1984).

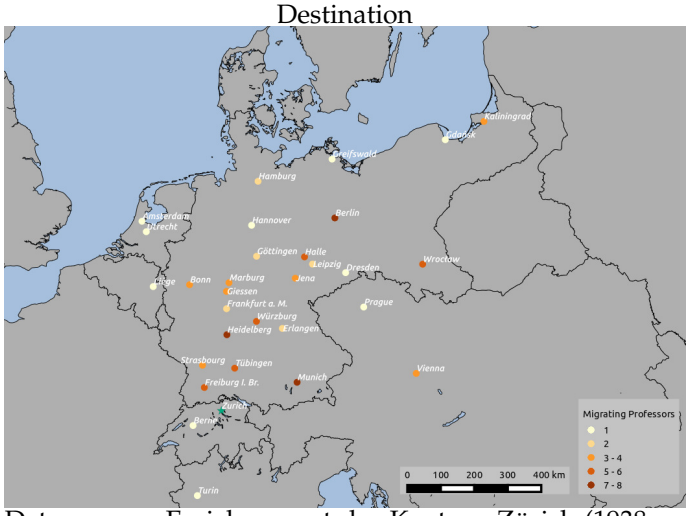
[8] There are 7 economists: Atoine-Elisée Cherbuliez (1797-1869), Gustav Cohn (1840-1919), Pierre Charton (1853-1917), Max Turmann (1866-1943), and Eugen Böhler (1893-1977). Victor Böhmert (1829-1918) and Julius Platter (1844-1923) had a joint appointment with the UZH.

Figure 3.2: Professors at UZH 1833-1933: Origin and Destination

Origin



Destination



Data source: Erziehungsrat des Kantons Zürich (1938, p. 960-1001), Rektorat der Universität Zürich (1983, p. 665-748)

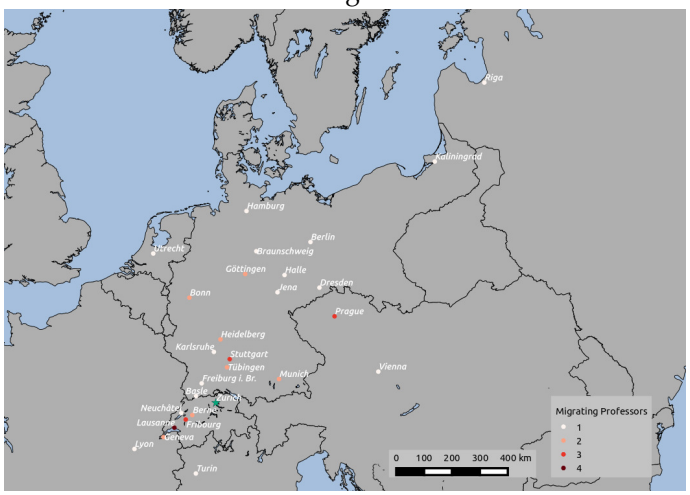
the *Professoren-Datenbank ETH* (Gugerli, 2004). The geographical distribution of origin and destination is displayed in Figures 3.2 and 3.3.

3.2.2 Incomes

To calculate the income differentials, which could potentially trigger a migration decision, we use the fixed part of the professors' income. The motivation for this choice is the income structure: the income sources were the basic salary, the enrolment fees (*Kollegiengelder*) and the examination fees (e.g. Ringer, 1990, p. 37). Since the flexible part of the income was to a large extent dependent on the

Figure 3.3: Professors at ETH 1855-1933: Origin and Destination

Origin



Destination

Data source: Eidgenössische Technische Hochschule (1955, p. 226-254), Gugerli (2004)

attractivity of the courses offered, the number of students enrolled[9], as well as to exogenous determinants such as a war, the fixed part can be seen as an important "safety net" determined in the negotiations with the university.

For the duration analysis later on, we restrict the sample to end in 1913, although the data on the professors would allow an analysis until 1933. The reason is that we want to avoid dealing with the turmoils caused by the First World War, the hyperinflation in Germany and the outbreak of the Great Depression. All in all, the period after 1913 is characterized by a severe reduction in the number of foreign professors in Zurich.

[9] At least initially, during the founding years, student numbers at UZH and ETH were still low, so that the low fixed income could hardly be compensated by the flexible part.

Teaching at the UZH started in spring term 1833, with 7 full professors (Moser, 2011, Vol. I, p. 1-4) and 161 students (HSSO, Table Z.14a). The university was founded by cantonal law on September 28, 1832. The teaching load was fixed at 12 hours per week for full professors and 5 hours for associate professors. The law set the annual salary of full professors to 2625 Fr. (Erziehungsrat des Kantons Zürich, 1938, p. 191), which was less than at the universities of Basle and Berne, and soon turned out to be too low to attract foreign professors. This fact forced the cantonal government to create a fund with the purpose to finance boni for outstanding professors (Meyer, 1939, p. 29-43). Still, average income remained low, but nevertheless, the political situation in Europe made Zurich attractive for foreign professors: all of the 7 professors teaching in spring 1833 came from Germany. Incidentally, the foundation of the UZH took place at the time, of the failing liberal *Vormärz* struggles in the German states (1830-1848).

The ETH was founded by federal law on February 7, 1854. The plan was to hire 32 professors, with a budget of 103000 Fr. (69 per cent of the total budget), which implies an average annual base income of 3200 Fr. (Eidgenössische Polytechnische Komission, 1854, p. 92-93).[10] Similarly to UZH, there was a fund to finance income increases for outstanding professors. The budget had to be increased regularly (1859, 1863, 1873, 1881, 1886, 1887, 1895, 1901),[11] leading also to an increase in the income of professors. The main argument in favor of income raises was always the lack of competitivness with respect to comparable institutions in Germany and Austria (e.g. Bundesrat 1887, p. 139-140, Bundesrat 1893, p. 362). Table 3.1 contains an overview on the development of annual incomes at UZH and ETH. For UZH, we calculated annual average incomes of professors based on the expenditure data reported in Meyer (1939). For ETH, the data come from the federal budget,[12] and, if not available, from the minutes of the supervisory authority in charge of the technical universities (*Schulrat*).[13] The deflator comes

[10] It was planned to hire seven outstanding full professors, at an annual income of 4000 Fr., and, in addition, four part-time professors with an annual income of 2000 Fr.. The remaining 21 professors should get an annual income of 3200 Fr.. The commission was not sure about the competitiveness of the proposed salaries (Eidgenössische Polytechnische Komission, 1854, p. 92-93).

[11] See the overview in Bundesrat (1910, p. 69-71).

[12] `www.amtsdruckschriften.bar.admin.ch`

[13] `www.sr.ethbib.ethz.ch/digbib/home`

from Studer and Schuppli (2008, Table A-2, p. 151-152).

Table 3.1: Annual Income (Fixed Part) of Full Professors in Zurich, 1833-1913

	UZH		ETH
	Minimum (Fr.)	Maximum (Fr.)	Average (Fr.)
1832	2625		
1855			3200
1857			4000
1859	2500	4000	
1860	3200	4000	
1863			4390
1864	3600	4500	
1873			4800
1893			6600
1900	5000	6000	
1901			7200
1913	8000	9000	

Sources: Meyer (1939, p. 29-63), Eidgenössische Polytechnische Komission (1854, p. 92-93), Bundesrat (1859, p. 69), Bundesrat (1863, p. 972), Bundesrat (1873, p. 1020-1021), Bundesrat (1893, p. 381)

What was the position of a typical professor's income in the income distribution for public servants in the canton of Zurich at the time? The data reported in Meyer von Knonau (1844, 1846, Vol. 2, p. 269) allow a comparison of professors' incomes with the income of employees of the adminstriation and judicial authority in Zurich around 1846. The distribution is based on 125 individuals, with an average income of 1060 Fr. and a median income of 595 Fr.. Table 3.2 shows that a full professor obtained the maximum income possible (the same as the two mayors and the two presidents of the court, see Meyer von Knonau 1844, 1846, Vol. 2, p. 269, fn. 1), while an associate professor earned an income close to the 75 per cent quantile. The income of the full professor was 342 per cent above median, while for the associate professor, the difference was 96 per cent.

Compared to other public servants in the canton, professors were obviously well paid, especially if we take into account that the figures discussed here are only the fixed part of the income. But for the decision to stay or leave Zurich the potential alternative income at a foreign university was also important. Between 1810 and 1945, Berlin (*Königlich Preussische Friedrich-Wilhelms-Universität zu Berlin*, founded 1810) is seen as the outstanding German university, followed by Munich and Leipzig (Baumgarten, 1997, p. 224-225, 265-266). In our data, a total of 6

Table 3.2: Administration and Judicial Authority in Zurich: Income Distribution around 1846 (Fr.)

Administration		UZH	
Maximum	2625	Full Professor	2625
75 Per Cent Quantile	1165	Associate Professor	1167
Median	595		
25 Per Cent Quantile	471		
Minimum	365		

Sources: Meyer (1939, p. 29-63), Meyer von Knonau (1844, 1846, Vol. 2, p. 269)

professors left Zurich for Berlin (UZH: 5, ETH: 1),[14] which is 7 per cent of the total number leaving. Moreover, the maps with the destinations in Figures 3.2 and 3.3 show that there is a wide dispersion of destinations across German speaking regions. The figures in Table 3.3 indicate that there is a positive correlation between the ranking of universities and attractivity for Zurich professors as measured by the number of professors hired from Zurich, at least for the UZH. For the ETH, the relationship is not clear. We decided to use average incomes of German

[14]This does not include the technical university (*TH Berlin*), the business school (*Handelshochschule Berlin*), and the *Kaiser-Wilhelms-Institut*. In total, 10 professors left Zurich for Berlin.

Table 3.3: Destinations: University Ranking

	Ranking		Attractivity	
	Science	Arts	UZH	ETH
Berlin	1	1	3	4
Munich	2	2	2	4
Leipzig	3	3	6	4
Bonn	4	4	5	5
Heidelberg	5	5	1	4
Göttingen	6	6	6	2
Halle	7	7	3	4
Strassburg	8	8	5	3
Tübingen	9	9	3	3
Würzburg	10	10	3	1
Breslau	11	11	3	5
Freiburg	12	12	2	4
Marburg	13	13	4	4
Jena	14	15	5	4
Königsberg	15	14	5	3
Kiel	16	16	8	5
Giessen	17	17	4	5
Erlangen	18	18	6	5
Greifswald	19	19	7	5
Rostock	20	20	8	5

Sources: Baumgarten (1997, p. 224-225, 265-266), Erziehungsrat des Kantons Zürich (1938, p. 960-1001), Rektorat der Universität Zürich (1983, p. 665-748), Eidgenössische Technische Hochschule (1955, p. 226-254), Gugerli (2004). Note that the list of German universities does not include technical universities and business schools.

professors from the University of Bonn (*Königlich Preussische Rheinische Friedrich-Wilhelms-Universität zu Bonn*) based on the individual data reported in Maus (2013, p. 311-366) as comparison. This university was in a similar situation, in the sense that it was not yet fully established. Re-founded in 1818 to strengthen the Prussian influence in the Catholic and Francophile Rhineland (Charle, 2004, p. 34), the university had to hire professors from abroad, since it could not draw from a local pool (Baumgarten, 1997, p. 168-169, 234). In terms of ranking, it was considered as directly following the top universities Berlin, Munich, and Leipzig (Table 3.3),[15] hence, it can be seen as an example for an attractive alternative to Zurich. For the German time series, we used Desai (1968)[16] as deflator. The data

[15]See Lexis (1904, p. 336-340) and Titze (1995, p. 96-97) for a brief overview on the history.

[16]Desai, Ashok V., (1968 [2005]) Reallöhne in Deutschland von 1871 bis 1913. GESIS Köln,

for Bonn are not available before 1841, therefore, our sample has to be restricted to 1841-1913.

We follow Williamson (1995) to make the real income series internationally comparable. The first step is to calculate

$$\frac{w_t^{Bonn}}{w_t^j} = \frac{\frac{w_t^{Bonn}}{w_0^{Bonn}}}{\frac{w_t^j}{w_0^j}} \frac{w_0^{Bonn}}{w_0^j}; j = UZH, ETH, \tag{3.1}$$

where $\frac{w_t}{w_0}$ is the real income index, and $\frac{w_0^{Bonn}}{w_0^j}$ is the real income ratio for base year 0. To obtain the income ratio, we take German retail prices for 1910 reported in Hoffmann (1965, Tables 141, 142, 143, p. 574-591) and retail prices for Zurich (HSSO, Table H.27) in the same year, and calculate PPP based on a Zurich consumer basket[17] to express the Bonn income in Swiss francs.

The second step is to make the index in equation (3.1) comparable over time:

$$\frac{w_t^{Bonn}}{w_0^j} = \frac{w_t^{Bonn}}{w_t^j} \frac{w_t^j}{w_0^j}; j = UZH, ETH. \tag{3.2}$$

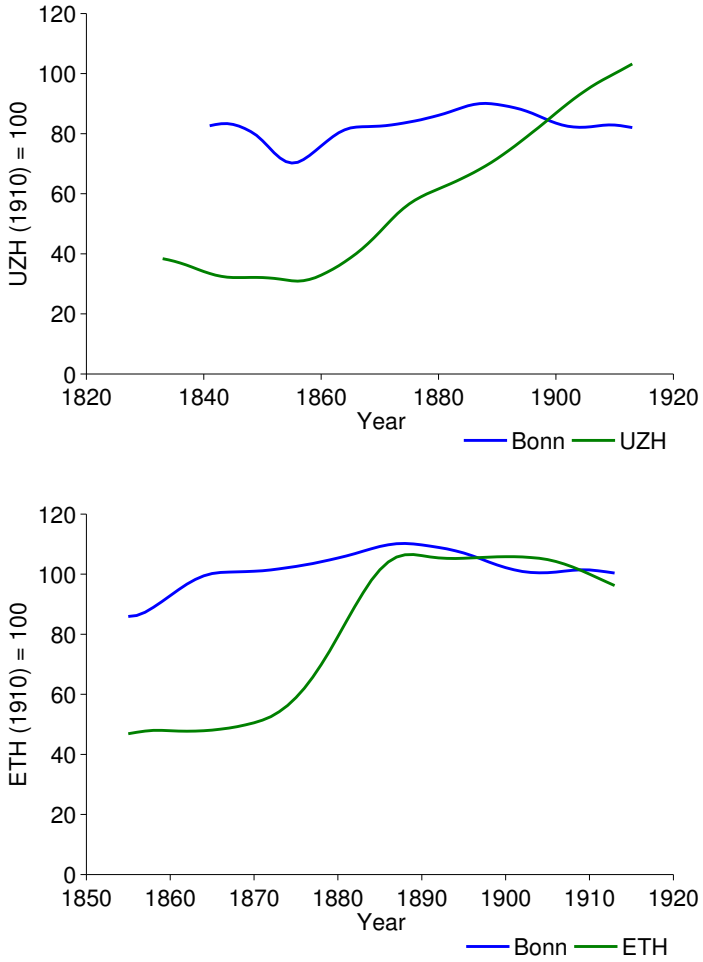
The results are displayed in Figure 3.4. Up until 1890 for the ETH and 1900 for the UZH, the incomes in Zurich are clearly below what professors could have earned in a German university as represented by Bonn, with an income differential of about 40 to 50 percentage points.[18] This outcome already points towards the importance of non-economic factors explaining the length of service of full professors at Zurich.

Deutschland ZA8216 Datenfile Version 1.0.0.

[17]The consumer basket is for a middle class family with two children in the period 1883-1910 (Duttweiler, 1915). We take average expenditure shares for 1899-1910 to smooth out irregular annual fluctuations.

[18]This finding is in line with the international real wage indices presented by Studer (2008, p. 450, Figure 10): Swiss wages are clearly below the other countries in the sample (Germany, Spain, France, Great Britain, Belgium, Netherlands), which is, to some extent, a result of the backward projection method applied (Studer, 2008, p. 428). However, Studer's results show that Swiss wages were low in the 19th Century.

Figure 3.4: Real Income Indices, 1833-1913 (Full Professors)



The data are smoothed using the Hodrick-Prescott filter (Hodrick and Prescott, 1997) with a smoothing weight of 100.

3.3 Methodology

The anecdotal evidence presented in this paper points to the importance of political events for the migration decision, against the background of a high propensity to leave due to integration problems for German professors. To quantify the determinants of length of service, we model the spells of full professors from Germany and Switzerland at UZH and ETH for the observation period 1833-1913[19] in terms of survival analysis and apply a proportional hazards model.[20] For the survival analysis we only include professors of Swiss or German nationality. Leav-

[19]Data on the income gap is available from 1841-1913.
[20]See e.g. Winkelmann and Boes (2006, p. 251-278).

ing UZH or ETH to take up employment at a university outside of Switzerland is coded as the failure event. The hazard rate $\lambda(t|\mathbf{x}_{jt})$ for an individual professor is defined as

$$\lambda(t|\mathbf{x}_{jt}) = \lambda_0(t) \exp\left(\mathbf{x}_{jt}\boldsymbol{\beta}\right); \lambda_0(t) > 0, \tag{3.3}$$

where $\lambda_0(t)$ is the baseline hazard of leaving UZH or ETH for employment abroad[21], and $\mathbf{x}_{jt}$ is a vector containing individual specific explanatory variables varying over time. To facilitate parameter interpretation, we calculate hazard ratios as

$$\frac{\lambda(t|\mathbf{x}_{jt} + \Delta\mathbf{x}_{jt})}{\lambda(t|\mathbf{x}_{jt})} = \frac{\lambda_0(t) \exp\left((\mathbf{x}_{jt} + \Delta\mathbf{x}_{jt})\boldsymbol{\beta}\right)}{\lambda_0(t) \exp\left(\mathbf{x}_{jt}\boldsymbol{\beta}\right)} = \exp\left(\Delta\mathbf{x}_{jt}\boldsymbol{\beta}\right). \tag{3.4}$$

The vector $\mathbf{x}_{jt}$ contains a dummy indicating whether the professor was German or employed at ETH. Various dummies indicating whether a professor was employed in Zurich over certain time periods are included. The observations for each professor are made up of the semesters employed in Zurich. Event dummies can thus be defined up to semesters to allow for the accurate specification of time and event dummies.

This allows us to specify political turmoil dummies indicating, for example, whether political events such as 1848/49, the Austro-Prussian War (1866), the Franco-Prussian War and Unification (1871), the *Kulturkampf* (culture struggle, 1871-1879), and the *Sozialistengesetz* (Anti-Socialist Laws, 1879-1890) took place during a semester in which a professor was at risk to leave Zurich for academic employment abroad. The political dummy is supposed to measure events leading to discontent among the liberal/national groups. The Austro-Prussian War resulted in the establishment of Prussian Hegemony and the *Kleindeutsche Lösung* (Lesser German Solution) of the German Question by the exclusion of the Austrian empire. At the same time, the re-orientation of the liberal parties towards supporting the policy of Bismarck was interpreted as an opportunistic compromise by more principled progressives (e.g. Nipperdey, 1983, p. 790-803).

[21] We choose to define the failure event as professor leaving Zurich for employment at a university outside of Switzerland, because we want to explore the phenomenon of German expatriates choosing against staying in Switzerland after experiencing the *Tonhalle Riots* as an anti-German event. Note also, that in the vast majority of cases the alternative employment chosen by an German professor in Zurich is a German university.

For the time after 1871, which turned out to become a focal point of this project, there are a number of influences, some in opposing directions, to be expected: On the one hand, the unification led to excitement among German nationalists in Zurich and implied a larger labour market for academics, with new universities founded, especially technical universities, over the course of the following years. Moreover, it led to an already mentioned increase in anti-German feelings in the Swiss public. On the other hand, the turmoils of the *Kulturkampf* and the campaign against the Social Democratic Party created an oppressive climate in Germany.[22] All in all, the estimated parameters for a given time period have to be interpreted as measuring a combination of the different push and pull effects in Zurich as well as in the German states at the time. Since the *Tonhalle Riots* were so appalling to the local German expatriates[23], we are confident that this event had a strong push effect.

In addition to the political dummy, the vector $\mathbf{x}_j$ contains the average income gap[25] during a given semester. To allow for the possibility that mobility is age dependent, it also contains the age and age-squared of the professor during his semester in Zurich. The spell of professors dying in Zurich and moving on to other Swiss universities are treated as right-censored.

3.4 Results

How do the characteristics of professors hired at Zurich compare to those hired by German universities? The data collected in Baumgarten (1997) allow such a

[22] In his autobiography, Sieveking [1935] (1977, p. 104) quotes the letter of a friend, complaining about the "*Kasernenluft*" (barracks atmosphere) in Germany.

[23] Again we refer to qualitative evidence to substantiate this claim: Otto Benndorf, professor for archeology, quit his professorship in Zurich explicitly because of anti-German sentiment to take up unpaid employment in Munich. Former UZH rektor Adolf Gusserow, who was part of the organizing committee of the Tonhalle festivities left Zurich as did the non-academic but influential committee member, affluent banker and patron of the arts, Otto Wesendonck. Gottfried Semper, founding father of the architectural school at ETH left Zurich, as did the law professor Adolf Exner (both members of the committee). Urner mentions other professors leaving Zurich at the time, among them the law professor Alfred Boretius, who was in opposition with local democratic traditions, and others who might have left Zurich mostly for reasons related to family and health, but all in all the [24] and their aftermath were experienced as a blow among the German expatriates in Zurich, some of whom had built up the fledgling academic instutions and belonged to the most accomplished scientists, artists and business men living in Zurich at the time(Urner, 1976, p. 221-222).

[25] The income gap is calculated as ratio of the two real income indices (Williamson, 1995, p. 177).

comparison for the arts and science faculty in the periods 1815(1833)-1847, 1848-1879, and 1880-1913. The data displayed in Figure 3.5 show the average age at entry, the average length of service, the proportion of individuals hired from a full professor position, and the proportion of professors leaving. The average age at entry and the proportion of full professors hired measures at which stage of their career professors were hired at the institution in question, while length of service and the proportion of professors leaving reflects the ability of the institution to retain researchers with an option to leave. The German universities for which data are available are Giessen and Kiel as examples for small universities typically hiring professors at the start of the career, Heidelberg and Göttingen as medium size universities, and Munich and Berlin as examples for top German institutions, which hired typically professors at a more advanced stage of their career.

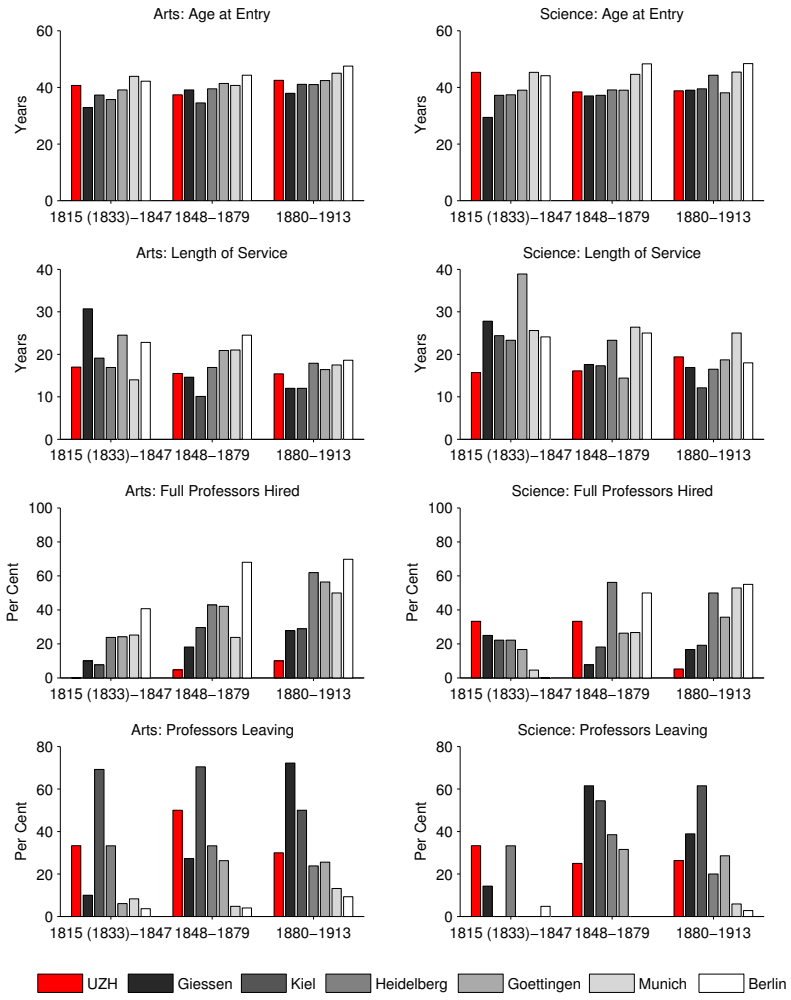
Baumgarten (1997, p. 182) characterizes the UZH as "entry-level university" (*Einstiegsuniversität*), following the assessment by Laspeyres (1882). This would make the UZH comparable to Giessen and Kiel, but Figure 3.5 shows that this is not straightforward. For the period 1815 (1833)-1847[26], age at entry is closer to the top universities, while for the later periods, both faculties look more similar to the faculties from the small German universities. The length of service stays almost constant over the three periods and does not allow a clear-cut classification for the UZH. In terms of share of full professors hired, the arts faculty is not successful compared with the German universities, while the science faculty is clearly more successful, apart from the period 1880-1913. The proportion of professors leaving the UZH is higher than for the top German universities over all three periods.

Table 3.4 contains the results for the UZH by faculty (theology, law, medicine, arts, science) and the ETH. The age at entry is about the same for the two universities, but the share of full professors hired is much higher for the ETH, while length of service is longer. There are also less professors leaving the ETH compared to the UZH.

An illustrative example for the characteristics of professors hired at Zurich before 1913 and their motivation to migrate are the economists. We zoom in on this

[26]This time period is congruent with the *Vormärz*, an era of mostly failing liberal and nationalist struggles in the German states.

Figure 3.5: Comparison of UZH Faculties with German Universities



Data source: Baumgarten (1997, p. 291-295), Erziehungsrat des Kantons Zürich (1938, p. 960-1001), Rektorat der Universität Zürich (1983, p. 665-748)

group, which we have studied more closely, in order to validate and contextualize the quantitative findings for the complete sample of full professors below. Among them were well known scholars: Bruno Hildebrand (1812-1878), Victor Böhmert (1829-1918), Julius Wolf (1862-1937), and Heinrich Herkner (1863-1932). For some of them, political events triggered the migration decision: Hildebrand, the co-founder of the Older Historical School in Germany, had to flee from Germany as a consequence of his political activities during the 1848 revolution. He stayed at UZH from 1851 to 1855, and left for Bern, where he taught from 1855 to 1861. Böhmert, co-founder of the *volkswirtschaftlicher Kongress*,[27] taught at UZH from

[27]The free-trade pre-decessor of the *Verein für Socialpolitik* was founded in 1858, see Böhmert

Table 3.4: Characteristics of Professors Hired at UZH and ETH

	UZH						
	I	II	III	IV	V	Total	ETH
Age at Entry (Years)							
1833-1847	32.0	32.9	35.9	40.7	45.3	35.6	
1848 (1855)-1879	37.9	37.9	37.1	37.4	38.4	37.6	37.8
1880-1913	41.8	36.1	40.0	42.5	38.8	39.7	37.8
Length of Service (Years)							
1833-1847	20.3	6.4	6.5	17.0	15.7	11.8	
1848 (1855)-1879	17.6	12.9	11.9	15.5	16.1	14.1	18.5
1880-1913	18.8	14.7	17.2	15.4	19.4	17.0	20.8
Full Professors Hired							
1833-1847	0.0%	12.5%	12.5%	0.0%	33.3%	10.3%	
1848 (1855)-1979	0.0%	25.0%	15.0%	4.8%	33.3%	15.1%	32.9%
1880-1913	0.0%	5.9%	19.0%	10.0%	5.3%	9.2%	19.4%
Professors Leaving							
1833-1847	42.9%	62.5%	75.0%	33.3%	33.3%	55.2%	
1848 (1855)-1879	42.9%	45.0%	56.5%	50.0%	25.0%	46.4%	27.8%
1880-1913	20.0%	52.9%	33.3%	30.0%	26.3%	33.3%	19.4%

I: Theology, II: Law, III: Medicine, IV: Arts, V: Science. Data source: Erziehungsrat des Kantons Zürich (1938, p. 960-1001), Rektorat der Universität Zürich (1983, p. 665-748), Eidgenössische Technische Hochschule (1955, p. 226-254), Gugerli (2004).

1866 to 1874 (joint appointment with the ETH). According to his autobiography, he could not feel comfortable any more in Zurich after 1871/72, when public oppinion turned against Germans as a consequence of the victory of Prussia over France and the unification of Germany(See Böhmert (1900, p. 42)).[28]

Herkner (at UZH from 1898 to 1907) is probably best known for his book on the labor question (*Die Arbeiterfrage*, 1894), which saw eight editions. He left Zurich for Berlin, where in 1913, he was hired as successor of Gustav von Schmoller (1838-1917), the head of the Younger Historical School. From 1917 to 1929, he served as president of the *Verein für Socialpolitik*.[29] Wolf, who taught as full professor at UZH from 1889-1897, is usually known as supervisor of the doctoral dissertation

(1900); Hentschel (1975).

[28]The hostilities in Zurich culminated in the so-called *Tonhallekrawall* from March 9, 1871, a violent protest against the celebration of the unification and victory organized by Germans (Urner, 1976, p. 207-222).

[29]For Herkner, see his autobiography (Herkner in Meiner 1924, p.77-116) and Backhaus and Hanel (1994). Herkner's doctoral dissertation on the cotton industry in Upper Alsace (1887) was supervised by Lujo Brentano (1844-1931), another important member of the Younger Historical School, and deemed as influential enought to cause a three years lasting quarrel between Brentano and Schmoller (Brentano 1917, p. 92-102, Brentano 1931, p. 126-129, 134-135, Backhaus and Hanel 1994, p. 47-53).

of Rosa Luxemburg, but wrote an (at the time) widely discussed critique of socialism (*System der Sozialpolitik*, 1892) and campaigned for an economic unification of Europe (*Mitteleuropäischer Wirtschaftsverein*).[30] The fact that Herkner and Wolf are honorably mentioned by Schumpeter in his *History of Economic Analysis* (Schumpeter [1954] 1984, p. 765, 947, 1076-1077) is also evidence for the standing of professors at Zurich. In their autobiographies, both Herkner and Wolf comment on the integration problems of German academics into the Swiss society, which made the decision to leave Zurich easier.[31]

None of the full professors in economics hired before 1913 stayed at the UZH, but left after an average of 6 years.[32] This is different for the ETH: here, the average length of service of full professors in economics was 19.4 years. This difference can be attributed to the fact that there are no Swiss among the economics professors at UZH. As can be seen from Figure 3.6, this result is typical across all disciplines at the two universities over the entire observation period 1833 (1855)-1933. For a display of how attrition rates of German and Swiss professors at both institutions in Zurich evolved over time refer to Figure 3.7[33]. Again, there is a clear difference between Swiss and German professors. German professors exhibit a much higher rate of attrition than the natives. Note also, that the linear trend indicates convergence over the the period of observation: Swiss professors become more mobile to consider alternative employment abroad and German professors more likely to stay in Switzerland.

The results from the survival analysis are displayed in Tables 3.5 to 3.8. Without highlighting any specific time periods, the results in Table 3.5 report the hazard ratios for the available covariates. As would be expected from the evidence in Figure 3.6 and 3.7, the results in column 1 show that being German raises the probability of leaving Zurich for employment abroad. For the specifications in

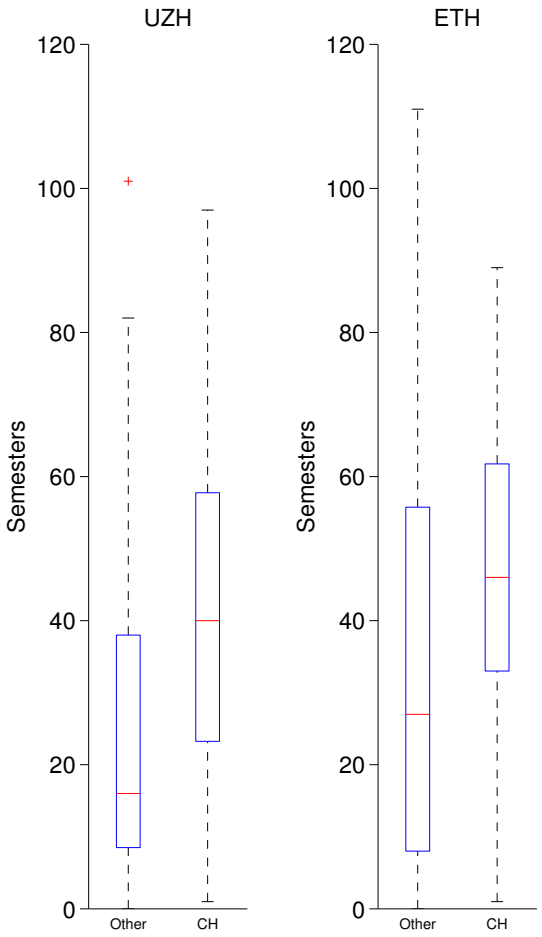
[30] On Wolf, see his autobiography (Wolf in Meiner 1924, p. 209-247) and Kiesewetter (2008).

[31] See Herkner in Meiner (1924, p. 103), Wolf in Meiner (1924, p. 213), and Urner (1976) for a general overview covering the period until the First World War.

[32] The average increases to 7 years if we include Heinrich Sieveking (at UZH from 1907-1921). But according to the epilogue in his autobiography, Sieveking was effectively on leave from autumn 1916 on (Ahrens in Sieveking [1935] 1977, p. 115).

[33] Note the singular peak attrition exceeding 13% among German professors in the fall semesters of 1871 and 1872: In spring of 1870, 36 Germans are employed as full professors. Between the spring semester of 1870 and 1872, 11 German professors have left (almost 20% of all full professors employed in Zurich at the UZH and ETH in 1870).

Figure 3.6: (Unconditional) Length of Service in Zurich by Country of Origin, 1833 (1855)-1933

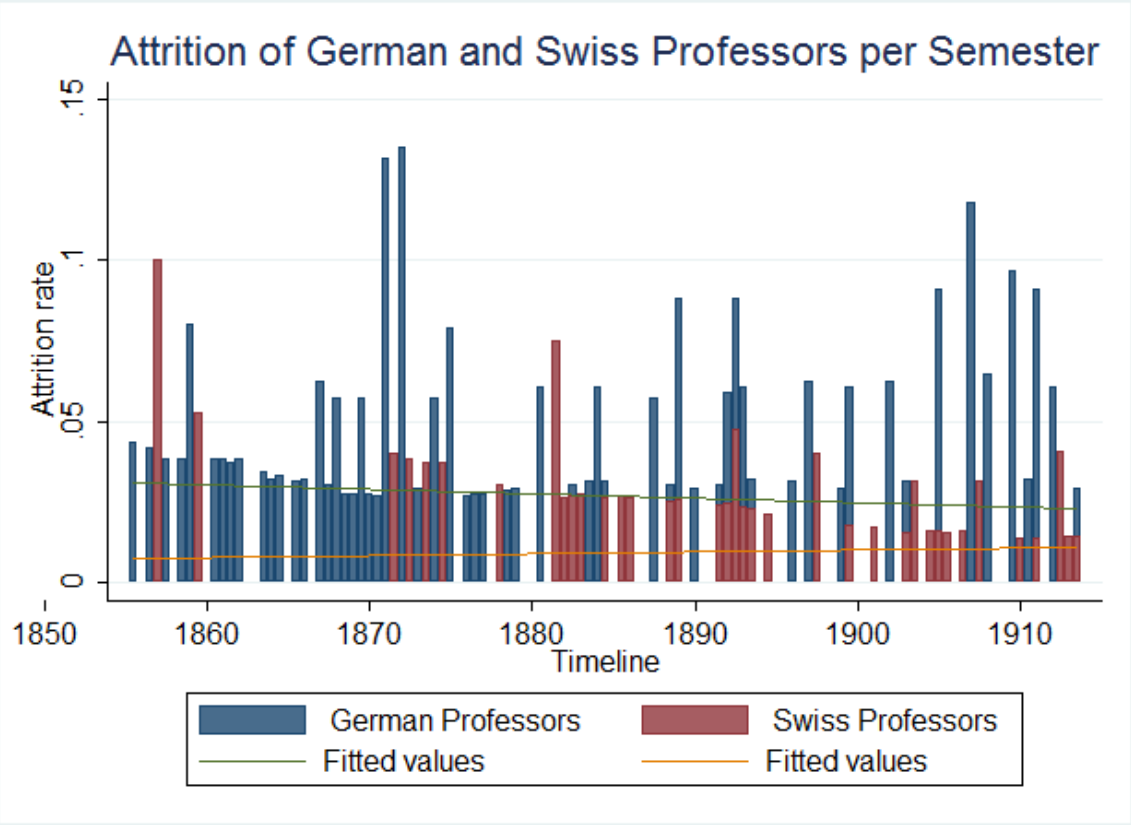


Only full professors; data source: Erziehungsrat des Kantons Zürich (1938, p. 960-1001), Rektorat der Universität Zürich (1983, p. 665-748), Eidgenössische Technische Hochschule (1955, p. 226-254)

column 1, 5 and 6 the baseline hazard increases by a factor between 2 and 3. The size of the effect is robust to different specifications. There seems to be an institutional difference between ETH and UZH in their ability to retain academic talent, which was already reflected in the figures presented in Table 3.4.[34] A professor at ETH is about half as likely to leave Switzerland for employment abroad. This finding and the size of the effect is robust over different specifications

[34]Note, however, that the observations for the ETH professors start only in 1855 and that the hazard of German professors is generally lower in the second half of the time span as reported in 3.6.

Figure 3.7: Attrition of German and Swiss Professors per Semester



and holds even when the income gap[35], which accounts for the differences in the wage level between ETH and UZH, is included as a control (see column 2, 5 and 6). The coefficient for the income gap is statistically significant and points into the expected direction for the model in column 3: if the wage level at the German reference university is twice as high as at the UZH or ETH in Zurich, the hazard increases by 50% compared to the baseline. Note, however, that the size of the effect drops to zero when the German-dummy and the ETH-dummy are included in columns 5 and, additionaly, age and age-squared in column 6.[36]

Furthermore, we can control for the age of professors. To capture non-linearities, a quadratic term is included in the specification. Columns 4 and 6 show that the effect for age is robust even when the other covariates are included In order to interpret the captured non-linearity, note that the corresponding point estimates for the underlying coefficients in column 6 are -.2604167 for the linear and .0025069 for the quadratic term, setting the first derivative of the effect equal

[35]The income gap is calculated as ratio of the two real income indices (Williamson, 1995, p. 177).
[36]Testing the interaction of the income gap with the German-dummy does not reject the null as long as a German-dummy is included in the specification.

Table 3.5: Hazard Ratios for Germans, ETH, Incomegap and Age

	(1)	(2)	(3)	(4)	(5)	(6)
GER	2.806***				2.706***	2.536***
	(0.000)				(0.000)	(0.000)
ETH		0.511***			0.519***	0.502***
		(0.000)			(0.000)	(0.000)
INC			1.572**		1.090	1.006
			(0.004)		(0.602)	(0.972)
AGE				0.756***		0.771***
				(0.000)		(0.000)
AGE^2				1.003***		1.003***
				(0.000)		(0.000)
N	9063	9063	8799	9063	8799	8799

Hazard Ratios from Cox Proportional Hazards Estimation
Exponentiated coefficients; *p*-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

to zero yields an age of 52 years as the minimum of the quadratic function: up to an age of 52 years, a professor's hazard of leaving Zurich falls and after that it increases at an increasing rate. Above, we have characterized UZH as an entry-level university and observed that entry-age at ETH was similar. This finding is in line with career paths of junior professors who start their careers in Zurich. Those who do not leave early for a university abroad tend to stay for a significant share of their productive years and move on to better posts as they reach the peak of their professional lives. None of these covariates need to be interpreted as causal for the purposes of this project. Instead, they will serve as control variables for the estimates in Tables 3.7 and 3.8, when we identify the effect of sharply discontinuous and narrowly defined political events.

As a next step in our survival analysis, we let the data determine how the hazard from being German has evolved over time compared to the baselinze hazard of Swiss professors in Zurich. The hazard ratios are reported for the interaction term between the time period and being a German professor. We begin by slicing the data in smaller and smaller intervals. The results presented in Table 3.6 report the hazard for two (column 1), three (column 2), four intervals

(column 3) and for decades in column 4. Compared to the baseline hazard of being Swiss, they display the increased hazard of being German over time. The results are in line with the point estimate of 2.8 reported for the German-dummy in column 1 of Table 3.5. They reveal, that the hazard of German professors leaving was higher during the first half of the period of observation.

Table 3.6: German Hazards over Time I

	(1)	(2)	(3)	(4)
1833-1870	3.346***			
	(0.000)			
1870-1913	2.573***			
	(0.000)			
1833-1860		3.523***		
		(0.000)		
1860-1887		2.894***		
		(0.000)		
1887-1913		2.435***		
		(0.000)		
1833-1853			3.526***	
			(0.000)	
1853-1873			4.020***	
			(0.000)	
1873-1893			2.379***	
			(0.000)	
1893-1913			2.138**	
			(0.001)	
1833-1843				4.031***
				(0.001)
1843-1853				3.107**
				(0.005)
1853-1863				3.465***
				(0.000)
1863-1873				4.373***
				(0.000)
1873-1883				2.268**
				(0.005)
1883-1893				2.505**
				(0.002)
1893-1903				1.665
				(0.131)
1903-1913				2.550***
				(0.001)
N	9063	9063	9063	9063

Hazard Ratios from Cox Proportional Hazards Estimation
TDs are interacted with GER-dummy
Exponentiated coefficients; *p*-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In order to tease out possible discontinuities in the data we slice the data even

further to account for 5-year intervals in Table 3.7. In Table 3.7 column 1 we report the results again without the set of controls to cover the maximum time span.[37] Looking through the results in chronological order it is again apparent that the hazard of German professors drops over the course of the 19th century as was found in the estimates reported in Table 3.6. Interestingly, with the finer slicing of 5-year intervals, two episodes stand out: First, observe that the generally very high hazard of German professors sharply drops to the level of their Swiss colleagues for the period of 1845-1850. This coincides with turmoil and failing liberal revolutions in the German states 1848/49, that were identified as the causes for many liberal and progressively minded German professors to seek refuge in Zurich. The second discontinuity is to highlight that towards the end of the 19th century, when the hazard of German professors more and more approaches the level of their Swiss colleagues, rises again for the period of 1870-1875 to a level that is only topped by the German hazard rate that is reported for 1840-1845 at the beginning of observations. The period of 1870-1875 coincides with the anti-German sentiments that culminated in the *Tonhalle Riots* and the new opportunities for academics in the newly found German empire as outlined above.

As a robustness test for the identification of these sharply discontinuous episodes we now include the full set of control variables[38] and report the results in Table 3.7 column 2. Again, the point estimates for 1845-1850 yield a small hazard rate - the smallest for all the reported time periods. The hazard rate reported for 1870-1875, on the other hand is now the highest hazard rate reported for any of the covered periods.

The tests reported in Table 3.7 let the data determine how the hazard of the German professors changes over time. The foreign German professors are more mobile than the native Swiss professors. We observe a general trend with the Germans and their Swiss colleagues slowly converging in terms of attrition rates towards the end of the 19th century. The periods of 1845-1850 as well as 1870-1875 stand out, with 1845-1850 indicating a very low hazard and 1870-1875 indicating a very high hazard. Furthermore, these periods coincide with events identified in

[37] Income data only becomes available from 1841 onwards.
[38] Note, that now we exclude all observations before 1841, for which income data is not available.

Table 3.7: German Hazards over Time II

	(1)	(2)
1833-1840	4.152**	
	(0.003)	
1840-1845	5.491***	2.582
	(0.000)	(0.197)
1845-1850	0.901	0.642
	(0.918)	(0.686)
1850-55	4.802***	3.973*
	(0.000)	(0.014)
1855-1860	3.724***	3.776**
	(0.001)	(0.008)
1860-1865	2.507*	2.528
	(0.025)	(0.067)
1865-1870	3.541***	3.205**
	(0.000)	(0.004)
1870-1875	5.195***	4.692***
	(0.000)	(0.000)
1875-1880	2.465*	2.017
	(0.013)	(0.064)
1880-1885	2.204	2.025
	(0.053)	(0.087)
1885-1890	1.749	1.486
	(0.201)	(0.371)
1890-1895	2.884**	2.779**
	(0.004)	(0.007)
1895-1900	1.930	2.277
	(0.132)	(0.064)
1900-1905	0.820	0.945
	(0.742)	(0.926)
1905-1910	3.394***	3.841***
	(0.000)	(0.000)
1910-1913	2.383*	2.470*
	(0.037)	(0.047)
ETH		0.497***
		(0.000)
INC		0.897
		(0.734)
AGE		0.760***
		(0.000)
AGE^2		1.003***
		(0.000)
N	9063	8799

Hazard Ratios from Cox Proportional Hazards Estimation
Exponentiated coefficients; *p*-values in parentheses
TDs are interacted with GER-dummy
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

our qualitative analysis of biographies of German professors and in the historiographic literature.

In a last iteration, we use this information to pinpoint the timing of the events which we suspect to be causal and report the results in 3.8. For convenience of reference to what we have found for our controls, we report the results from Table 3.5 column 6 again in column 1 of Table 3.8. In columns 2 to 4 we now include the political turmoil dummy 1848-1850 for the failed liberal revolution in Germany and a political turmoil dummy 1871-1872 for the *Tonhalle Riots*. Note, that instead of fully specifying all other time periods interacted with the German-dummy, we include instead a German-dummy to control for the difference in hazards between Swiss and German professors in the sample as a whole. The point estimates and their corresponding hazard ratios suggest that the hazard for a German professor to leave Zurich for employment outside of Switzerland increased by a factor of three in the aftermath of the *Tonhalle Riots* and that this German-specific hazard dropped sharply for the period of the failed liberal revolutions in Germany.

As pointed out above, the ETH and UZH lost about 20% of their full professors within two years after the *Tonhalle Riots*. It must have been problematic for the management of ETH and Zurich to deal with the sudden increase in fluctuation and to find suitable replacements at such short notice. In Table 3.9 we present data on the entry-age of hired professors and on the share of full professors recruited (as opposed to initial appointments) over three consecutive 5-year periods from 1866-1880. We find that the age of entry remains stable for the UZH hires but drops temporarily during 1871-1875 for the ETH and recovers later. The share of full professors hired in this period drops at both institutions for the period of 1871-1875 and recovers partially in 1876-1880. We interpret this as evidence, that ETH and UZH - at least temporarily - had to resort to hiring more junior faculty members in order to fill the vacancies left by the high attrition among German professors after the *Tonhalle Riots*. It stands to reason that replacing 20 per cent of the faculty with comparatively less accomplished professors (if younger age and initial appointments are taken as an indicator) may have had negative long term consequences for the institutional development of UZH and ETH beyond the five-year period in which recruiting success dropped.

Table 3.8: Main Results

	(1)	(2)	(3)	(4)
GER	2.536***	2.385***	2.552***	2.400***
	(0.000)	(0.000)	(0.000)	(0.000)
ETH	0.502***	0.499***	0.499***	0.496***
	(0.000)	(0.000)	(0.000)	(0.000)
INC	1.006	0.982	1.046	1.017
	(0.972)	(0.915)	(0.794)	(0.923)
AGE	0.771***	0.771***	0.770***	0.771***
	(0.000)	(0.000)	(0.000)	(0.000)
AGE^2	1.003***	1.003***	1.003***	1.003***
	(0.000)	(0.000)	(0.000)	(0.000)
1871-1872		3.174***		3.108***
		(0.000)		(0.001)
1848-1850			0.358	0.397
			(0.314)	(0.366)
N	8799	8799	8799	8799

Hazard Ratios from Cox Proportional Hazards Estimation
TDs are interacted with GER-Dummy
Exponentiated coefficients; *p*-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.9: The Aftermath of the *Tonhalle Riots*

	1865-1870	1871-1875	1876-1880
UZH			
Entry-Age	36	36	36
% Full Professors Hired	67%	35%	54%
ETH			
Entry-Age	35	33	38
% Full Professors Hired	67%	20%	33%

3.5 Conclusion

In 2011, professors in Switzerland earned more on average than professors in any other country: 78 per cent more than professors in neighboring Germany, 35 per cent more than their colleagues in Britain and 55 per cent more than at US-American universities (NZZ, 20.05.2012). On average, professors in Switzerland have financially favorable conditions. This was not the case in the 19th Century, when Switzerland was still among the poorer countries in Europe, which is also reflected in the salaries the universities were able to pay. Swiss universities at the time could benefit from the turbulent situation in Germany in terms of attracting and retaining highly qualified researchers to build the fledgling UZH and ETH.

In the period under study, Zurich was both considered a safe haven by refugee academics from abroad as well as a place to be fled for xenophobic outrage at different times. For two landmark events, the failed liberal revolutions in the German states in 1848/49 and the *Tonhalle Riots*, we find that political turmoil mattered greatly in either keeping professors from leaving or giving them reasons to leave. This finding holds for a survival analysis applying a proportional hazards model to the complete set of full professors employed at UZH and ETH and the inclusion of several controls, including the income gap. Whereas the German expatriate professors were much more at risk to leave the university of Zurich for academic employment outside of Switzerland in general, they were not more likely to leave during the political turmoil of the failed liberal revolutions and were much more likely to leave in the aftermath of the anti-German *Tonhalle Riots*.

These findings have to be taken with a grain of salt, on the one hand, we cannot control for unobserved variables that make either foreign universities or Zurich

more or less attractive, on the other hand, the precise timing of the events make us confident that we have indeed estimated an effect that is at least partly driven by the highlighted events. Moreover, we also find that the income gap (wages at UZH and ETH were much lower than at a comparable university in Germany initially and converged only slowly) did not matter in determining the duration of employment spells during the period under study. This finding emphasizes the main finding, of how important the incidence of political turmoil was relative to the income gap. Moreover, we present evidence, that both UZH and ETH hired more junior faculty to replace the missing professors than they hired before and several years after the *Tonhalle Riots*.

Although the 19th century events portrayed here cannot be compared to current situations in Switzerland and abroad, they are part of our collective historical experience and contribute to how we frame what we observe today. The quantitative analysis shows that the concerns raised by our contemporaries in Switzerland, today, were in principle valid for the period that we have studied: Political turmoil and social developments that are considered by expatriates as xenophobic have had substantial impact on the recruitment and retention of faculty at UZH and ETH in the 19th Century - even when differences in salary were large, they have not mattered as much.

Chapter 4

Long Run Effect of District-Based versus License-Based Hunting on Roe Deer Populations in 20th Century Switzerland

4.1 Introduction

One class of problems studied in institutional economics relates to the management of open-access resources. These are resources that, on the one hand, cannot be effectively excluded from being used by others, and, on the other hand, diminish in quality the more they are used. In the language of economics, these resources are non-excludable and rivalrous (Samuelson, 1954). Such properties make them prone to degradation through excessive use. In a completely world, say an unregulated open-access regime, the negative externalities imposed by harvesting on other users, contemporaneously and in the future, are not taken into account in the current period. The contemporaneous externality involves the overcommitment of resources to harvesting. In the case of hunting this overcommitment could be, for example, too many hunters, too many cars, too many dogs, too much effort committed to a hunting area. As a result, hunters in open-access regimes get a lower rate of return for their hunting efforts. The future externality is borne by hunters in the next hunting season because excessive hunting will have lowered the stock of huntable game animals in the next period. Therefore, the open-access regime results in over-exploitation and lower net returns for

hunters in the long run.[1] Since Hardin (1968), the economic literature has coined the term *Tragedy of the Commons* for this concern. Looking back on the past 100 years of publications in the *American Economic Review* Stavins (2011) holds that the problem of managing the commons has still not been solved in many contexts and that the search for solutions is more timely than ever. With economic and population growth, our concerns with carrying capacity and environmental quality have become ever more pressing. His survey includes a recent discussion of examples and current challenges in our understanding. The over-fishing of open-access fisheries is a relatively well-examined one.

A related example, the one that is studied here in the 20th century Swiss context, is over-hunting of game populations.[2] This issue of excessive exploitation of the resource persists and emerges in other contexts, too, including problems with pollution and global warming. Economists often recommend to assign private property rights in order to ensure efficiency of use. There is a strong theoretical case for the privatization of the renewable resource: the sole owner will only employ such effort in the current period as is warranted by his returns and he will balance his current harvest value against the asset value of the resource.[3] The costs of proper privatization, however, for some of these resources can be prohibitive. On a more positive note, Elinor Ostrom's research on institutions[4] has revolved around local solutions that have ameliorated the commons problem through the development of institutions and informally overcoming problems of collective action (at least partly) even when privatization was not implemented (1990 and 2010).

In the case of hunting regulation in Switzerland, we can observe important changes across cantons and time, and also, a pronounced dichotomy of fundamentally different institutions that has emerged: the license-based regime (LBR)

[1]The original finding in the literature goes back to Gordon (1954), for a textbook exposition refer e.g. to Tietenberg and Lewis (2012, p. 328).

[2]The problem of open-access fisheries management is very closely related to open-access game populations: it is hard to exclude other users from harvesting and users impose negative externalities on each other. An important difference, however, is that game populations also impose negative externalities on agriculture and forestry (Kaegi, 1911, p. 14), which makes it harder to determine and to sustain the socially optimal population level.

[3]The original finding goes back to Scott (1955), for a textbook exposition refer e.g. to Tietenberg and Lewis (2012, p. 329).

[4]For which she has received the 2009 Nobel Memorial Prize in Economic Sciences.

and the district-based regime (DBR). This dichotomy and changes in the period of observation will be exploited for the empirical strategy. To illustrate the institutional context some historic background is in order: under the Ancien Régime the use of game populations for hunting was an exclusive privilege held by local elites. This exclusivity prevented the stock of game animals to be over-hunted and gave an incentive to the privileged classes to protect and foster game populations looking forward. A considerable stock of game animals was preserved and could be harvested sustainably.

As discussed in Chapter 2 of this thesis, the Napoleonic Era brought institutions of the French Revolution to Switzerland, with considerable benefit for the treated regions. The impact on Swiss wildlife was less benign: under the Helvetic Republic, Swiss wildlife became the common property of the nation.[5] Considered a former privilege of the higher classes, hunting was opened for all citizen in 1800. The ensuing surge in unregulated hunting activity had immediate and detrimental results for Swiss wildlife. To provide for a modicum of regulatory control, the License-Based Regime (LBR) was introduced by the Helvetic Republic in all cantons. The LBR allowed all citizens who paid the corresponding fee to hunt anywhere in the canton. No privilege existed for landowners. Moreover, it was ineffectively monitored, closed seasons and the protection of certain species were not obeyed because they lacked virtually any effective enforcement. Predictably, the stocks of huntable big game soon collapsed almost completely. Big game like Red Deer, Wild Boar and Ibex became extinct with only scant and scattered populations of Roe Deer and Chamois surviving. The historiographic literature covering this period illustrates the *Tragedy of the Commons* mechanism (e.g. Breitenmoser and Breitenmoser-Würsten (2008, p. 124-126) and Schmidt (1956, p. 14-26)).

With the exception of Aargau, which was the first canton to introduce a District-Based hunting regime (DBR) in 1803[6] when the cantons regained their sovereignty

[5]Note, that the inneralpine cantons had hunting rights for all free men, based on medieval law, even under the Ancien Régime and, correspondingly, seriously depleted stocks of game all along. These cantons typically adopted even the loosest of LBR regulations only after being forced to do so by federal law in 1876 (Schmidt, 1976, p.134-139).

[6]The Canton Aargau adopted the LBR temporarily in 1837-1838, but has remained regulated by the DBR ever since.

in hunting matters, Swiss big game stocks did not recover until more effective and better enforced regulation was introduced and continuously expanded towards the end of the 19th century at the federal level, the 1875 *Bundesgesetz über Jagd und Vogelschutz* and, subsequently, at the cantonal level (Blankenhorn, 2008).

Swiss cantons today know both the LBR (Appenzell Innerrhoden, Appenzell Ausserrhoden, Bern, Fribourg, Glarus, Graubünden, Jura, Neuchâtel, Nidwalden, Obwalden, Schwyz, Ticino, Uri, Vaud, Valais, Zug) and the DBR (Aargau, Basel-Landschaft, Basel-Stadt, Luzern, Schaffhausen, Solothurn, St. Gallen, Thurgau, Zurich).[7] Over time, nine cantons have permanently adopted the DBR. The last adoptions of the DBR at the Cantonal level took place in 1941 in Luzern and 1950 in St. Gallen.[8] Comparing the two regimes, the LBR is an - over time increasingly regulated - open-access regime for all hunters in a canton, wheras, the DBR leases the exclusive right to hunt to a local hunting club at the municipal level. In the DBR, leases are over several years and typically perpetuated indefinitely. Thus, local hunting rights are held privately as common-property by a small group in the DBR. For game species, such as Roe Deer, that have relatively small home ranges, lying within the borders of a typical hunting district, the local resource becomes effectively privatized. On the continuum of open-access and common-property regimes, the institutional change of switching from LBR to DBR is thus interpreted as a substantial step from open-access to common-property, where the self-limiting and preserving mechanisms that Ostrom (1990)[9] found for small local communities are much more likely to kick in.[10]

Reviewing trends in the literature in 1998, Deacon *et al.* (1998, p. 390-392)

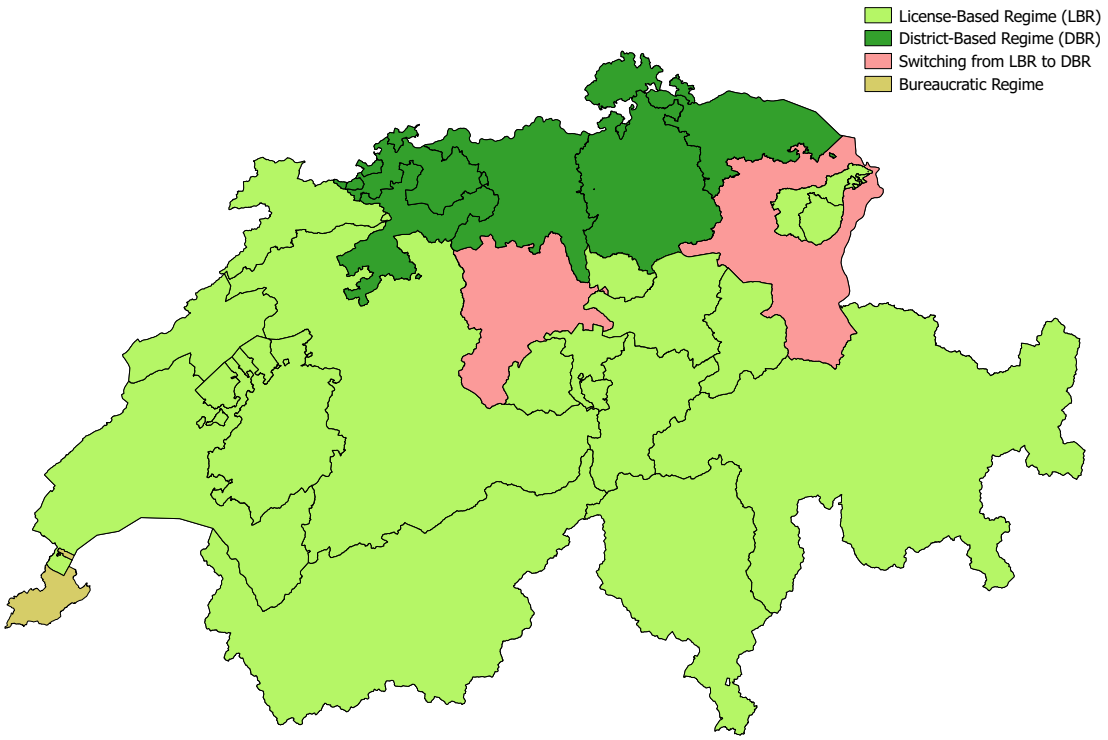
[7]The Canton of Geneva abolished private hunting activities in 1974. All hunting and game management activities are conducted by a specialised branch of the state bureaucracy (e.g. Baumann *et al.* 2014).

[8]Mixed systems with the choice of the hunting system at the municipal level have existed for transition periods over several years (e.g. Kurmann (1944, p. 49-55) and Steinmann (1950)).

[9]The conditions for long-enduring common property institutions are: 1. Clearly defined boundaries, 2. Congruence between appropriation and provision rules and local conditions, 3. Collective-choice arrangements, 4. Monitoring, 5. Graduated sanctions, 6. Conflict resolution mechanisms, 7. Minimal recognition of rights to organize (Ostrom, 1990, p. 90).

[10]The use of this terminology is not completely homogeneous in the literature. Platteau (2008), e.g. uses the terms open-access and common-property interchangeably. Other authors, like Stavins (2011) differentiate between the two terms, defining common-property resources as being held by a relatively small group with the option to exclude outsiders, whereas open-access resources are those that are non-excludable. The latter differentiation of terms will be used for the purposes of this project.

Figure 4.1: Hunting Regimes in Switzerland



Source: (Baumann *et al.*, 2014, p.25).

have called for better empirical measurement of key relationships between institutions and the exploitation of renewable resources. In the meantime, at least one landmark study has been undertaken, studying the differential impact of institutions on fisheries with the toolbox of panel data econometrics, e.g.: Costello *et al.* (2008). This study has shown, that fisheries that were managed with Individual Tradable Quotas (ITQs) were less likely to collapse.[11] The research project at hand is another step in the direction of better empirical measurement and estimating the size of the effect of institutional change as called for by Deacon *et al.* (1998) looking at game management in Switzerland. To the best of my knowledge, such econometric studies of specific institutional effects on population dynamics do not exist for the effect of hunting regulations in the recent empirical economic literature.

In the Swiss context a rudimentary study comparing the average of harvested

[11]ITQs "work by allocating a dedicated share of the scientifically determined total catch to fishermen, communities, or cooperatives. This provides a stewardship incentive; as the fishery is better managed, the value of the shares increases"(Costello *et al.*, 2008, p. 1679).

game animals from Swiss cantons, differentiating LBR and DBR, with figures from Western Germany and Austria from 1954 to 1966 was undertaken by Blaupot ten Cate (1968). And even in the relatively well-studied field of fisheries our understanding of different institutions is still scant and patchy. The study by Costello *et al.* (2008), for example, works with a panel data set covering fisheries for different species all over the globe. A principal concern with such empirical studies and the one at hand is selection bias: were the institutional changes implemented where they were most likely to yield a benefit, or where conditions were improving anyways? Can these features be sufficiently controlled for by observables?

A salient feature of the study at hand, is that the observations are drawn for the same species from an area of extraordinary geographic proximity in which fundamentally different institutions are applied. The geographic proximity, the study of one species and the fact that all observations were drawn from the institutional, social and cultural context of Switzerland makes it more likely, that explanatory factors that are unobserved (e.g. the impact of climate change, changes in national legistlation, etc.) are relatively homogeneous for the observations of Roe Deer in different cantons of Switzerland, compared to the the different species of fish studied all across the scope in the cited landmark study for institutional impact on fisheries.

The remainder of this paper is structured as follows: the data from the Federal Hunting and Area Statistics as well as on the institutional background are presented in Section 4.2. Section 4.3 discusses the applied methodology. Section 4.4 presents the results of the transition from the LBR to the DBR on the Harvesting Density of Roe Deer. Applying a fixed effects panel data model with a full set of yearly time dummies and a specification that allows for a variety of functional forms yields a time profile of the causal effect for the 50 years after the introduction of the DBR. Section 4.5 concludes.

4.2 Data

4.2.1 Federal Hunting and Area Statistics

This project draws on two main sources for data: first, the Federal Hunting Statistics and, second, the Federal Area Statistics. The number of harvested Roe Deer per canton is taken from the Federal Hunting Statistics for the period from 1933-2007. Yearly cantonal data for forested land from 1933-2007 is generated by linear interpolation of the Federal Area Statistics of 1923-24, 1952, 1972, 1979-85, 1992-97 and 2004-09. Note that the share of forested land is time-varying and has increased in many cantons as previously agricultural lands of low productivity were reforested over time (See Figure 4.2 and 4.3[12]). This is important, because the number of taken Roe Deer per Canton is proportional to the available habitat. Thus, the available habitat per canton is time-varying. A measure of harvest density (HD), the number of harvested Roe Deer per 100 ha of forested land is then used as the outcome variable (for the basic descriptive statistics refer to Table 4.1, for long run cantonal plots refer to Figure 4.4).

Table 4.1: Summary Statistics for HD

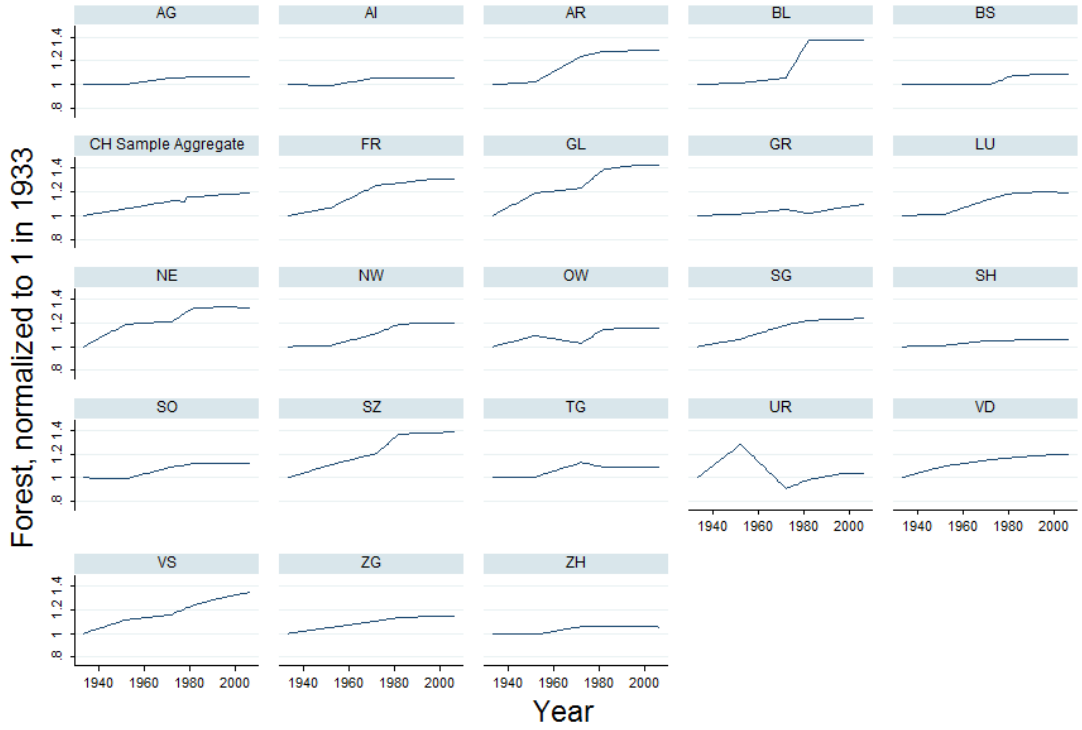
Variable	Mean	Std. Dev.	Min.	Max.	N
HD	3.596	3.031	0	16.503	1962

Two cantons are excluded from the sample for all estimates: Geneva, because it has chosen to organise hunting through a state bureaucracy in 1974 and the Canton Ticino because of data issues up until the early 1990ies. Excluding Geneva and Ticino also excludes two cantons that constitute the extreme West and South of Switzerland, thus making assumptions about comparable geographical and climate conditions across cantons more likely to hold. In the following, we first justify the choice of the HD measure and then the choice of Roe Deer as an indicator species.

Regarding the choice of the outcome variable, consider the difficulty of estimating game population dynamics: wild animals are notoriously hard to count.

[12]Highlighting the development of cantonal forests in Luzern and St. Gallen compared to the development of the aggregate of Swiss cantons to demonstrate that the baseline results presented later are not driven by an unusual pattern in the data on forested land.

Figure 4.2: Long Run Development of Cantonal Forests

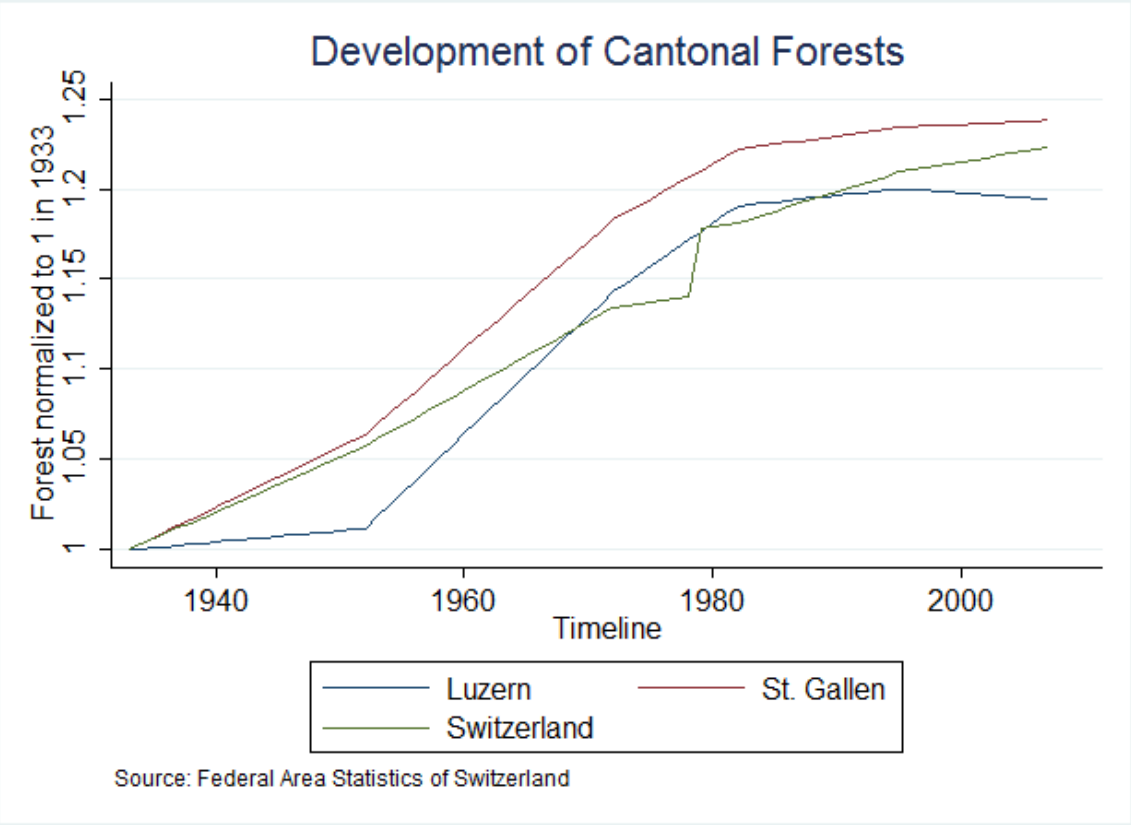


Source: Federal Area Statistics; Note that BE and JU are excluded because of division in 1979

Therefore, researchers have resorted to the use of hunting statistics as a proxy. Ueno *et al.* (2014) observe that hunting statistics have frequently been used in the literature, in particular, when it was the only proxy for population dynamics available across sufficiently large areas and time periods. Looking at Norwegian Moose populations across time and space for 16 regions from 1967-2005 (most regions cover a time-span of roughly 20 years), the authors find that using the number of harvested animals compares favorably to other proxies such as observational data and data from accidents with motor vehicles. According to Ueno *et al.* (2014) HD was most closely related with the number of moose both within and between areas and the only measure well-suitable for spatial comparisons. But, they find it was prone to exaggerated temporal variation and tended to overemphasize the growth and decline of populations.

With reference to Swiss hunting statistics Breitenmoser and Breitenmoser-Würsten (2008, p. 164-165) argues that yearly hunting statistics also reflect short-term variations of conditions that affect hunting or the population stocks, e.g. the weather conditions during the hunting season or a harsh winter that decimated

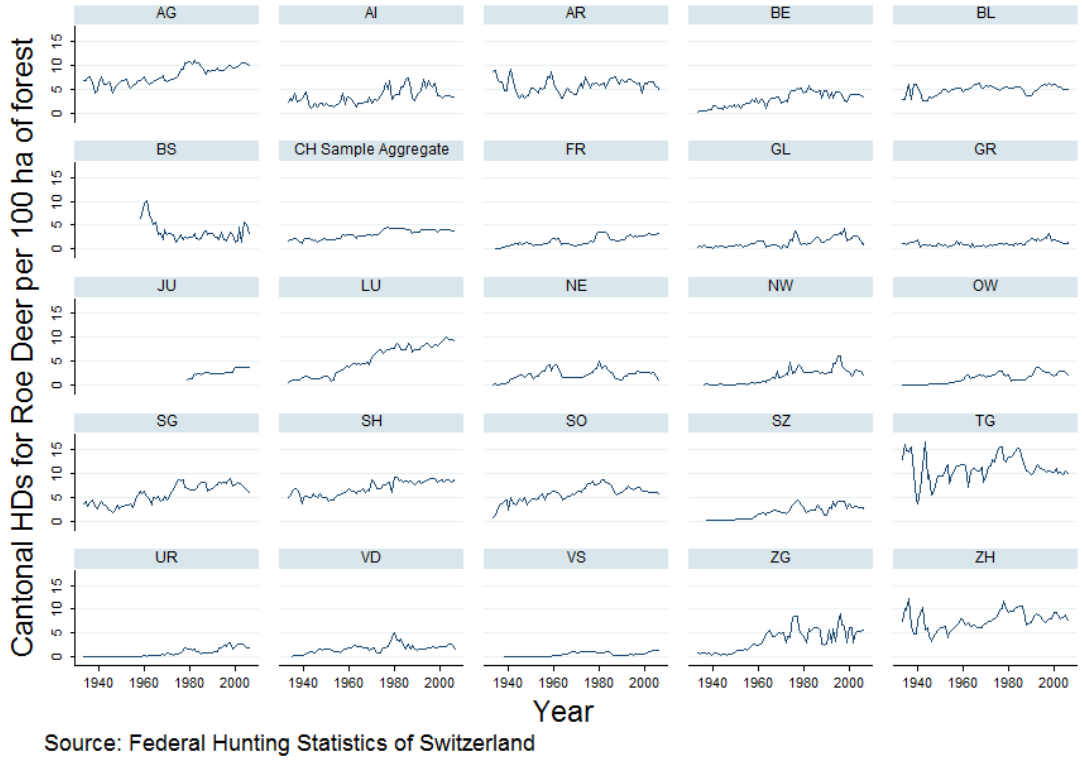
Figure 4.3: Cantonal Forests: Luzern and St. Gallen



the stocks. Both Ueno *et al.* (2014) and Breitenmoser and Breitenmoser-Würsten (2008) mention that HD statistics are a delayed measure of population dynamics. Delayed, for example, because the hunting authorities adjust the harvesting objectives for hunters based on their observations of increased or decreased stocks with a time lag. Furthermore, Breitenmoser and Breitenmoser-Würsten (2008) points out that in the medium run (5-10 years), rising HD could mean a reduction of the population if higher harvest rates are mandated to achieve this objective. In the long run, however, HD measures are argued to be good and valid proxies for estimating the dynamics of a population. For the purposes of this project the yearly cantonal data from the Federal Hunting Statistic are therefore considered to be not only the best available, but also suitable proxies.

In order to compare the effect of cantonal hunting regimes across Switzerland the analysis here is based on Roe Deer as an indicator species. This species was chosen for several reasons: first, it is quantitatively the most important game species for hunting in Switzerland, exceeding the number of harvested animals for Chamois and Red Deer (see Figure 4.5). Second, it is a species with homeranges

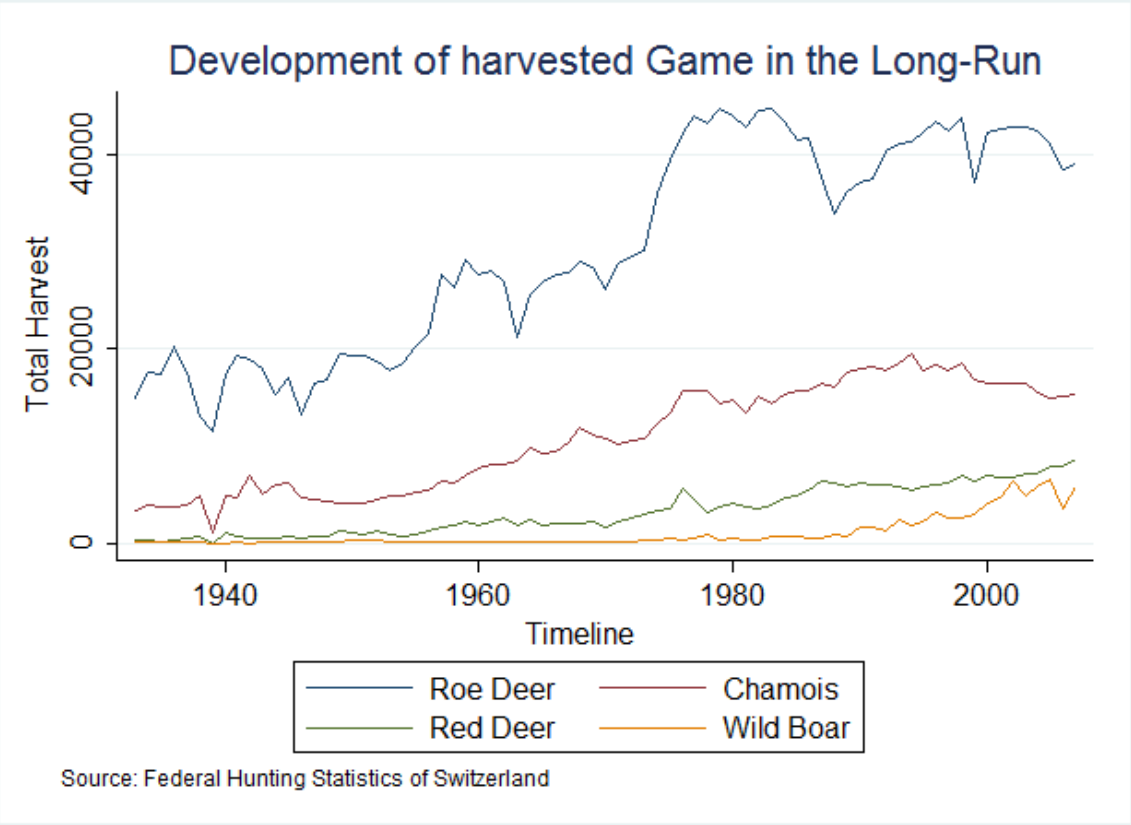
Figure 4.4: Long Run Development of Cantonal HDs for Roe Deer



that are small relative to the size of a hunting district. Therefore, the expected impact of the DBR is expected to be much higher for a local game resource such as Roe Deer, than for any of the other big game species.[13] Third, it is a species that exists in large numbers in all cantons. Excluding Geneva and Ticino, the HD for Roe Deer was higher than for Red Deer in all cantons except Graubünden and Valais, and higher than for Chamois in all cantons except for Glarus, Graubünden, Nidwalden, Obwalden, Uri and Valais.

[13]Homeranges for Roe Deer are smaller than 100 ha in Switzerland (Baumann *et al.*, 2014, p. 43). Other important big game species like Red Deer, Wild Boar and Chamois move around much more and very often across the boundaries of hunting districts. Therefore, the introduction of the DBR is not expected to have such effects on the increase these populations. For Red Deer, for example, a local hunter in the DBR can still have the incentive to harvest a stag whenever he legally encounters one in his district, because he usually cannot be sure, whether the stag will stay in his area.

Figure 4.5: Long Run Development of Big Game



4.2.2 Institutional History

The introduction of the DBR was highly contentious, often postponed and sometimes temporarily reversed by popular vote.[14] Broadly speaking, the administration was frequently interested in transition to the DBR which would allow them to generate a higher revenues from fees[15] and in cost reduction[16] for game management. The financially less fortunate hunters under the LBR were concerned they would loose access to their hunting grounds.[17] Agricultural and forestry interests were worried about increasing damage from higher stocks of game for which the tenants of a hunting district have to pay under the DBR.[18]

It turned out, that the expectation of the administrations was right: within a decade after introduction of the DBR at the cantonal level, the total income gen-

[14] In Zurich, for example, a law introducing the DBR was rejected by popular vote in 1906, 1917 and finally accepted in 1929. In 1936 a referendum initiated by the cantonal hunting association to reintroduce the LBR was rejected (Baur, 1955, p. 1-5).
[15] See e.g. Maag (1915, p. 48) and Kurmann (1944, p. 50-51).
[16] See e.g. Dommer (1948, p. 30-31).
[17] See e.g. Dommer (1948, p. 28-29) and Maag (1915, p. 46).
[18] See e.g. Maag (1915, p. 47).

erated from hunting increased by a factor of ca. 2.5 in Luzern (Kurmann, 1944, p. 54) and by ca. 3.5 in St. Gallen (Steinmann, 1950, p. 314). In Zurich, the income from hunting grew by a factor of 4.2 from 1927 under the LBR until 1951 under the DBR (Baur, 1955, p. 3-4). All of these observations are in line with the reading that the transition from the LBR to the DBR was in effect a privatization of hunting rights which internalised positive (increased yield, more hunting pleasure) and negative externalities of higher stocks of game (game management and compensation of damages). This rise in the fees generated fees is commensurate with the two well-established findings in the economics of renewable resources: first, rent dissipation under open-access (Gordon, 1954) and, second, to the finding, that resources are optimally managed, when the owner balances the current harvest value against the future asset value (Scott, 1955).

Consulting the historiographic literature, especially dissertations about cantonal and federal hunting law from the early 20th century, reveals that the accounts for the historical development of the hunting regulations, notably the years for the introduction, are somewhat contradictory. The most detailed accounts can be found in dissertations covering the legal transition from the LBR to the DBR on the cantonal level. Such detailed dissertations exist for the cases of Luzern (Kurmann, 1944) and St. Gallen (Steinmann, 1950), which is crucial for this study, because the institutional changes in these cantons are the basis for the empirical strategy.[19] They show not only the reversals, but also that the final introduction of the DBR at the cantonal level was sometimes undertaken with an intermediate step of offering the municipalities the option of introducing the DBR at the Municipal level.[20] This intermediate step is called facultative DBR in the literature. In Luzern, the DBR was first introduced in 1810 but immediately afterwards the LBR was reinstituted. In 1906, the cantonal executive wanted to introduce the fac-

[19] To my knowledge, such dissertations covering the institutional evolution are not available for all cantons. Blanc (1930) covers Fribourg, Thürer (1979) Glarus and Jörimann (1926) Graubünden in their dissertations. Good sources on the institutional history of Zurich are Baur (1955) and Maag (1915). Sources on the evolution of Swiss hunting regulation can be found in the dissertations of Kaegi (1911) who covers Swiss hunting law and Dommer (1948) who covers the DBR from a Swiss perspective. A historical account of Swiss hunting is provided by Schmid (2010) and, with an excellent overview on the choice of the hunting regime in different Cantons, by Schmidt (1976, p. 128-158).

[20] Kurmann (1944, p. 52-54) and Steinmann (1950, p. 67-69, p. 167, p. 247-248 and p. 284).

ultative DBR, in 1916 they proposed the introduction of the DBR at the cantonal level - these were rejected by popular vote - finally, in 1930 the facultative DBR passed a popular vote and most municipalities started switching to the DBR. In St. Gallen, the introduction of the DBR was rejected by popular vote in 1896, 1909, 1927 and 1932. In 1935 it was instituted by the executive as a temporary measure to finance the public deficit under provisions of emergency law during the Great Depression.

These intermediate steps and the reversals explain the contradictory accounts between sources that cover the development of hunting regulations of Swiss hunting regulations at the federal level. For pinpointing the final transitions to the DBR, this project relies on the two dissertations covering Luzern and St. Gallen as well as on a survey among the cantonal hunting authorities undertaken with the help of the Bundesamt für Umwelt (BAFU) (Bundesamt für Umwelt (2015)). Regarding the final transitions in the 20th century and the historical development of Luzern and St. Gallen the numbers should be accurate. For a more thorough picture covering each canton's history and to account for more complex transitions, much more archival work would be required at the various cantonal archives. Such work is beyond the current scope of this project. For the purposes of this study, we consider only the latest and final adoptions of the hunting regime. The other final adoptions of the DBR took place in 1838 in Aargau, 1832 in Basel-Land, 1877 in Basel-Stadt, 1921 in Schaffhausen, 1932 in Solothurn, 1930 in Thurgau and 1929 in Zurich.

Where available, the more detailed cantonal histories of hunting regimes show that even when the DBR was introduced, this decision was sometimes reversed. Even in cantons that had recently switched to the DBR, local hunters at the time could not be sure, whether the canton would again switch back to the LBR. Therefore, the effects on population dynamics that are measured here, are expected to accrue over decades after the last final adoption of the DBR. When local hunting clubs rent a district over longer time horizons with the perspective, that the restraint in hunting today and investing in habitat quality will add to the asset value of their hunting district, the huntable game population will increase over time. This incentive can only materialize when local hunters can be sure that

the hunting regime will not be changed again in the immediate future. In the vast majority of cases, the hunting district will be given to the previous local hunting club by the municipality, with individual hunters entering or leaving the club. This paper argues, that the typical local hunting club under the DBR has an infinite time horizon of using its local district as long as the macro-political environment is stable. Therefore, it is in order to take the final adoption of the DBR on the cantonal level as the starting point for these long run incentive to kick in and to measure it's effect on game populations accordingly.

It is in order to point out the minuscule size of Swiss cantons for which the hunting regimes differ. Whereas Hunting legislation in the USA or Germany may also vary across states, these political entities are much larger in size. With 41,284 square kilometers, all of Switzerland is about the size of New Hampshire and Vermont combined, about a tenth of the size of Califoria, or between the size of the German states of Baden-Würtemberg and Niedersachsen. The geographical, cultural and ecological proximity of the two different hunting regimes in Switzerland make it more likely that time-varying unobserved factors, such as e.g. regional weather-phenomena in a given year or the suitability of the local habitat for Roe Deer, the disease environment, predator-prey relations, competing species dynamics, developments in the legal framework of federal hunting laws, changes in the quality of legal institutions and law enforcement are fairly homogeneous. And even if there remain some time-varying unobservables, they are likely to be less problematic in the case of the given data for Switzerland, compared to studies that can be undertaken for much larger entities or for entities that are distributed across the globe as is the case with the above-cited fisheries studies.

4.3 Methodology

Theory on optimal use of renewable resources predicts that users will have a higher incentive to balance the current harvest value against the future asset value of the resource, when the institutional environment changes from an open-access

regime towards a common-property regime.[21] In the case of a canton switching from LBR to DBR, we expect the local hunters who rent the district will at first restrain themselves in their hunting activities and undertake other measures to increase the stock of huntable game in their district. They will be much less concerned, that an outside hunter will come and harvest animals that they have spared, because this is legally and effectively excluded under the provisions of the DBR, but legal under the LBR. Furthermore, if Ostrom (1990) is right, all remaining conflicts inside the local hunting community that are detrimental to the efficient management of the game population will much more likely be solved by a small, local community under the DBR than by the much larger hunting community of the canton. After several years, when the population has increased, it is expected that the hunters in that district will be able to harvest a much higher sustainable yield. This effect of the DBR on the population dynamics of Roe Deer is expected to materialize with a time-lag over the course of several decades.

The objective of this paper is to capture the yearly increases in the HD after the introduction of the DBR. The treated cantons are Luzern and St. Gallen. These are the two cantons that switched from the LBR to the DBR in the period of observation from 1933-2007. The treatment will be captured by the dummy Δ_{cy} which assumes the value of 1 for observations in Luzern after 1941 and in St. Gallen after 1950 and 0 for all others (see Equation 4.1).

Alternatively, and to reveal how the treatment effect materializes over time, the treatment will be captured by a year counter δ_{cy}, which accounts for the duration of the treatment in years after introduction for the Cantons of Luzern and St. Gallen. The specification in Equation 4.2) accounts for a linear time trend after introduction of the DBR.

To allow for more flexibility in the evolution of the effect after the institutional change, specifications with polynomial terms up to the 6th degree were tested. The control group is given by all Cantons that have either adopted the DBR before 1933 (Aargau, Basel-Landschaft, Basel-Stadt, Schaffhausen, Solothurn, Thurgau, Zurich) or have not adopted the DBR (the remainder of the Cantons except for

[21] For a textbook exposition see e.g. Tietenberg and Lewis (2012, p. 327-332).

Geneva and Ticino which were excluded from the sample).[22] The baseline specification includes polynomials up to the 4th degree (see Equation 4.3).

$$HD_{cy} = \tau_c + \theta_y + \beta_{1.1}\Delta_{cy} + \epsilon_{cy} \tag{4.1}$$

$$HD_{cy} = \tau_c + \theta_y + \beta_{2.1}\delta_{cy} + \epsilon_{cy} \tag{4.2}$$

$$HD_{cy} = \tau_c + \theta_y + \beta_{3.1}\delta cy + \beta_{3.2}\delta_{cy}^2 + \beta_{3.3}\delta_{cy}^3 + \beta_{3.4}\delta_{cy}^4 + \epsilon_{cy} \tag{4.3}$$

All these specifications include cantonal fixed effects τ_i and a full set of yearly time fixed effects θ_y. This is a flexible way to control for a host of unobserved characteristics: The cantonal fixed effects control for any unobserved characteristics of the canton that stay constant over time. This could be, for example, the remaining time-invariant difference in suitability of the canton as a habitat for Roe Deer. Bear in mind, that HD_{cy} of harvested Roe Deer per 100 ha of forest is determined relative to the time-variant measure of forested lands in the canton. Moreover, the standard errors are clustered at the cantonal level.[23]

The yearly time fixed effects control for unobserved characteristics that have affected the included cantons in a similar way. For example, the impact of weather conditions on hunting success in a given year, or climate change, or the impact of a harsh or mild winter on the stock of game populations, the general rise of HDs in the aggregate, changes in agriculture, changes in the disease environment, predator-prey relations, development of competing species, etc. The proximity of different hunting regimes in the case of Switzerland make it more likely, that unobserved trends will have affected the cantons in similar ways.

For robustness checks, we exclude cantons that are not adjacent to DBR cantons

[22] As a robustness test, evidence will be presented for an alternative specification in which all cantons are included as treated that have switched to the DBR in the 20th century: Schaffhausen, Solothurn, Thurgau and Zurich, which have adopted the DBR in 1921, 1932, 1930 and 1921. The control group includes the DBR cantons of Aargau (1838), Basel-Landschaft (1832) and Basel-Stadt (1877), which had permanently adopted the DBR more than 50 years before observations start in 1933, and the remainder of the cantons without Geneva and Ticino (See Section 4.2).

[23] One reason for clustering at the cantonal level is that cantonal data may be of different quality (particularly for observations at the beginning of observations), with cantons possibly adopting different methods in compiling the data or exerting different levels of effort in providing accurate and realistic numbers.

or for which Roe Deer is not the numerically most important big game animal. For those concerned, that the alpine characteristics of some of the LBR cantons drive the results, note that the baseline specification only includes the two alpine DBR cantons of Luzern and St. Gallen as treated.

Furthermore, note that the choice of adopting the DBR was not driven by social or conservational concerns, but primarily driven by financial needs in the aftermath of World War I and the Great Depression which hit Swiss cantons as a whole at the same time[24]. The financial needs of this era hit all cantons at the same time and had triggered similar political processes in both adopting and non-adopting cantons. The Cantons of Bern, Fribourg and Schwyz held popular votes in most of the others there were private or govermental initiatives to introduce the DBR. As the DBR was favored mainly by the more affluent hunters, whereas the median voter objected to privileges for the rich and wanted to keep hunting more affordable, the efforts to introduce the DBR were frequently delayed or failed altogether (Schmidt, 1976, p. 128-158).

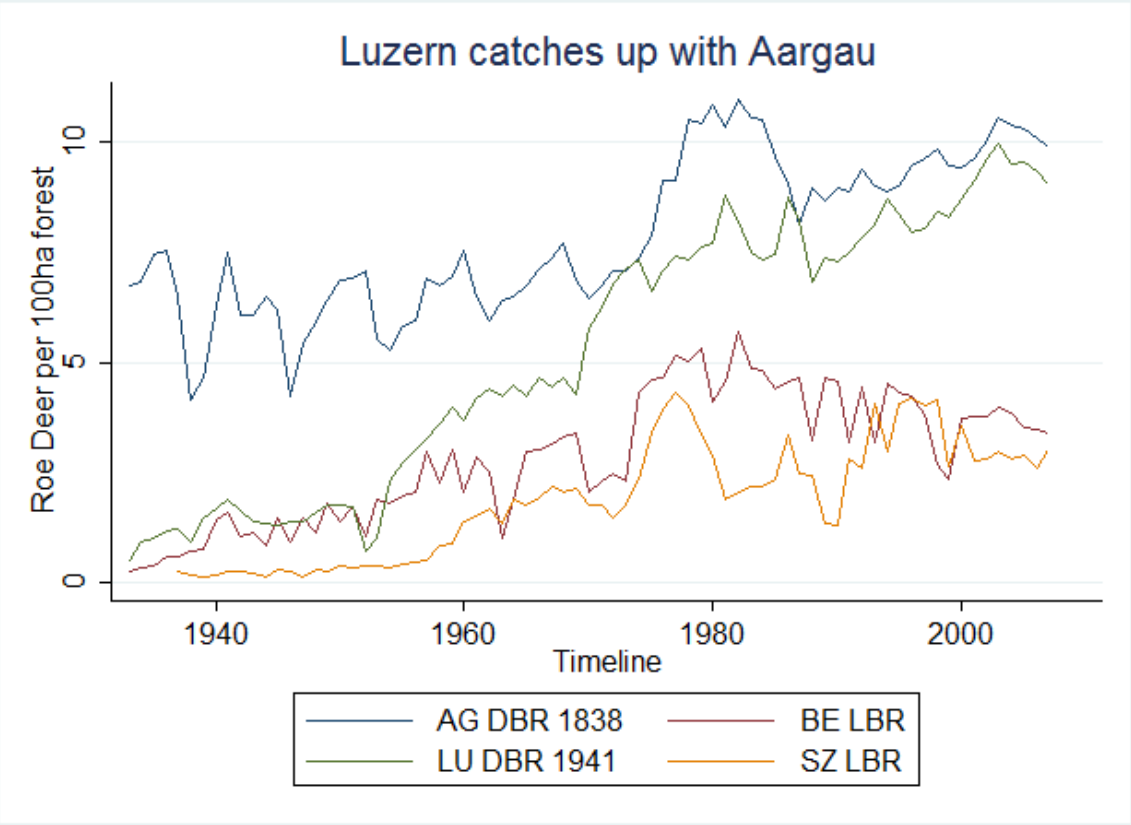
4.4 Results

4.4.1 Baseline Results

How do the yearly HDs of Luzern (DBR in 1941) and St. Gallen (DBR in 1950) compare to neighboring cantons before and after introduction of the DBR? Eyeballing the HD time series for Luzern in Figure 4.6 and for St. Gallen in Figure 4.7 provides a first impression that is in line with the theoretical predictions. It looks as if Luzern and St. Gallen approach the HD levels of their DBR neighbors over the course of several decades after transition to the DBR. Furthermore, Luzern's and St. Gallen's HD experience a steeper increase in absolute terms over the period of observation compared to their neighbors who adopted the DBR earlier or not at all.

[24]Most clearly this is stated by Schmidt: "Die Entscheidung der Kantone zu einem der beiden Jagdsysteme fiel zu keiner Zeit und in keinem Kanton nach sozialen und nur zum Teil nach wildschützerischen Gesichtspunkten, sondern ausschliesslich nach finanziellen. (...) *Die Entscheidungen in den Kantonen über das Jagdsystem gingen nicht von der Sorge um den Wildstand aus,* wennschon davon die Rede war"(1976, p.128, emphasized as in the source).

Figure 4.6: Luzern catches up with Aargau

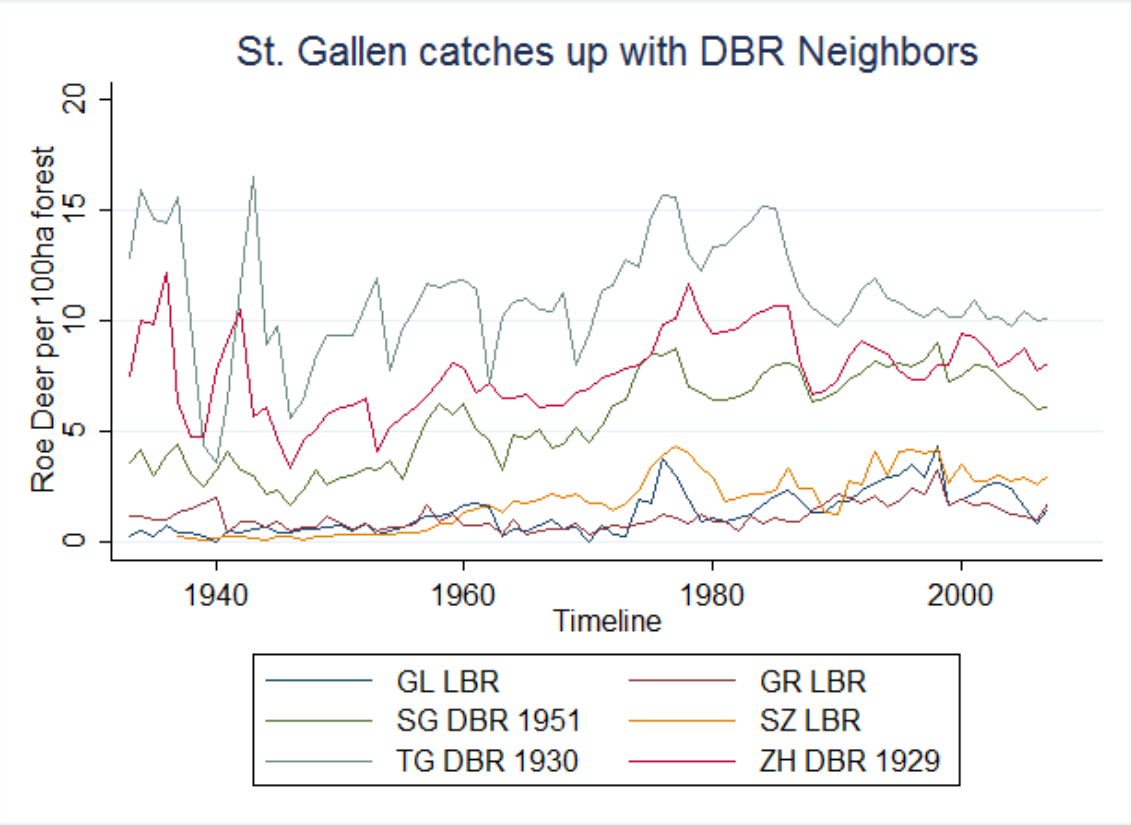


The next step is to present econometric evidence along what was outlined in Section 4.3. In Table 4.2 you find the baseline results of this paper. The model in the first column estimates the coefficient for a dummy that equals one for all observations for Luzern and St. Gallen after their respective introduction of the DBR. Thus, this dummy can be thought of as the average increase in HD for Luzern and St. Gallen after the treatment. The number of Roe Deer harvested per 100 ha of forest increases by 2 over the period of observation.

A second model with a linear trend is estimated to account for the average yearly increase over time. This estimate indicates an increase of the HD by ca. 4 Roe Deer over the course of 50 years. This figure is more or less in line with the graphical evidence from Figure 4.6 and Figure 4.7.

However, economic theory suggests that the eventual rise in HD should occur in two phases: first, a phase of temporarily restrained harvesting followed by a phase of permanently increased harvesting, when the stock of huntable game has increased sufficiently to allow for a higher sustainable yield. In order to capture such a non-linear effect, specifications with polynomials up to the 6th degree have

Figure 4.7: St. Gallen catches up with neighboring DBR Cantons



been tested. For the baseline results presented here, the non-linearities were best captured by a fourth degree polynomial. The results are presented in the third column.[25]

In order to better interpret the estimation results from the fourth order polynomial refer to the graph in Figure 4.8. Note, that the evidence from the third column of the baseline results suggests that HDs decline at first and then after five to ten years rise over time until they plateau after around 40 years. After 50 years HDs increase again more steeply. Given that these results estimate the treatment effect of switching to the DBR for the Cantons Luzern and St. Gallen, take note, that these cantons are observed only for roughly 60 years after the introduction. When reaching the plateau between 40 and 50 years after introduction, the increase amounts to 3-4 Roe Deer per 100 ha of forested land. This result is roughly consistent with the estimate for the linear trend in the second model of Table 4.2. Moreover, it is consistent with what would be expected from the economic

[25]The F-statistic for joint significance of the four polynomial terms amounts to 74.19 and the null can be rejected at all conventional levels of significance.

Table 4.2: Baseline Results

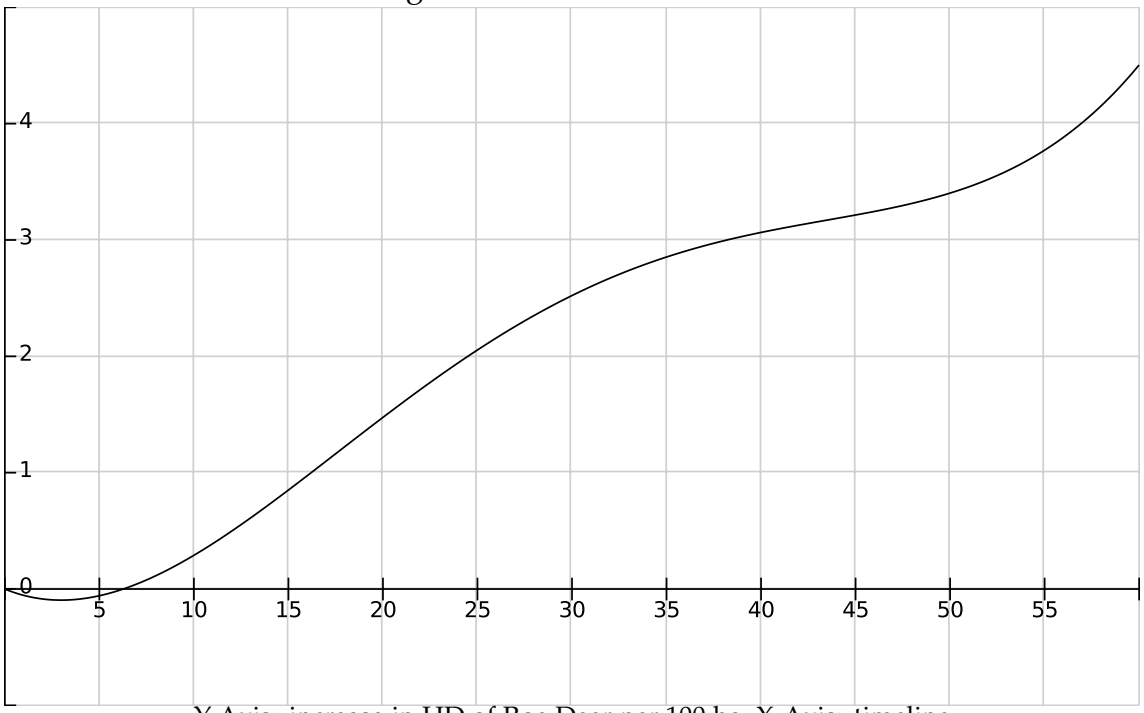
	(1)	(2)	(3)
DBR Dummy	2.213**		
	(0.002)		
Linear Term		0.0771***	-0.0669
		(0.001)	(0.205)
Quadratic Term			0.0127**
			(0.002)
Cubic Term			-0.000339***
			(0.000)
4th Order Term			0.00000278***
			(0.000)
N	1692	1692	1692

p-values in parentheses
with cantonal FEs and full set of yearly TDs, SEs clustered for cantons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

theory of renewable resources if the resource was depleted under the LBR and then recovers under the DBR.

These results are in line with theory-based expectations and they are statistically significant - but what about the size of the effect? Some back-of-the-envelope considerations based on the Federal Hunting Statistics and the Area Statistics of Zurich: a medium-sized hunting district has around 400 ha of huntable land, which includes both forested and agricultural land. With 171 districts and 50'300 ha of forest, a typical hunting district in Zurich would harvest ca. 30 Roe Deer per year on ca. 300 ha of forested land in the period of 2000-2007. If the Canton of Zurich had - hypothetically - not changed to the DBR, we would expect that 9-12 Roe Deer less would be harvested per district. This is a sizeable effect amounting to roughly a third of the annual hunting bag. For the Canton of Zurich, the provisions for auctioning the districts dictate that no more than CHF 300 per Roe Deer harvested should be charged as rent and the hunting laws dictate that in case of poaching the value of an adult Roe Deer will have to be compensated by CHF

Figure 4.8: Baseline Results



Y-Axis: increase in HD of Roe Deer per 100 ha, X-Axis: timeline in years.

200.[26] Consequently, an estimate of the increase in monetary terms would amount to CHF 1800-3600 per district and to ca. CHF 300'000-600'000 for the canton. The average Zurich hunter harvested ca. 2.5 Roe Deer per year, his annual bag would be reduced by a third without the DBR or 545 of the 1634 Zurich hunters would have to quit hunting to keep the annual bag per hunter at the current level (figures for 2007).

4.4.2 Robustness Checks

For the first set of robustness checks refer to Table 4.3. The specification of the econometric model is identical to the first, but here the cantons that do not share a common border with a DBR canton are excluded from the previous sample, namely Fribourg, Neuchâtel, Uri, Valais and Vaud. For the specifications in column 1 and 2, the results are equivalent. For the specification in column 3, the levels of statistical significance drop, but the graph in Figure 4.9 exhibits the same

[26] Refer to `www.aln.zh.ch/internet/baudirektion/aln/de/fjv/Jagd.html` for the provisions on auctioning and links to the cantonal hunting regulations.

characteristics as in the baseline specification.[27] These results alleviate concerns that the results might be driven by a comparison that includes cantons that are too different from the treated group with regard to, for example, geographical or climatic characteristics.

Table 4.3: Without non-neighboring Cantons

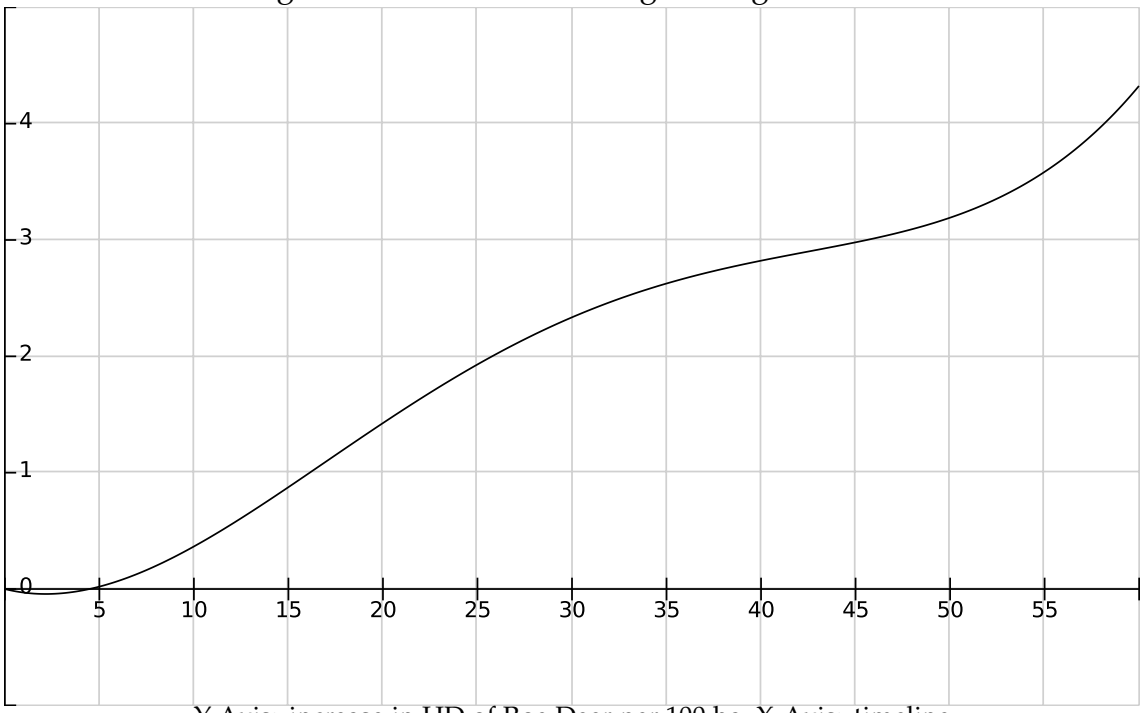
	(1)	(2)	(3)
DBR Dummy	2.141**		
	(0.008)		
Linear Term		0.0732**	-0.0408
		(0.003)	(0.467)
Quadratic Term			0.0103*
			(0.011)
Cubic Term			-0.000285**
			(0.002)
4th Order Term			0.00000240***
			(0.000)
N	1336	1336	1336

p-values in parentheses
with cantonal FEs and full set of yearly TDs, SEs clustered for cantons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For the second set of robustness checks refer to Table 4.4. The specification of the econometric models is again identical to the first, but here the cantons for which Roe Deer is not the numerically most important game species are excluded from the control group. As pointed out already in Section 4.2, Roe Deer is numerically more important than Red Deer in all cantons except for Graubünden and Valais, and numerically more important than Chamois in all cantons except for Glarus, Graubünden, Nidwalden, Obwalden, Uri and Valais. Therefore, these cantons are excluded from the control group here. For the specifications in column 1 and 2, the results are again equivalent. Regarding the specification in column 3, the graph in Figure 4.10 exhibits the same characteristics as in the baseline

[27] The F-statistic for joint significance of the four polynomial terms amounts to 52.78 and the null can be rejected at all conventional levels of significance.

Figure 4.9: Without non-neighboring Cantons



Y-Axis: increase in HD of Roe Deer per 100 ha, X-Axis: timeline in years.

specification.[28] It is conceivable, for example, that an increase in Red Deer in the control cantons had led to a crowding out of Roe Deer and thus driven the results. These results alleviate concerns that the results might be driven by a comparison that includes cantons where other big game species like Red Deer and Chamois are more important to the ecosystem and the cantonal hunting communities.

For the third set of robustness checks refer to Table 4.5. The specification of the econometric models is again similar to the baseline specification (a fifth order polynomial term is added for better fit), but note an important difference: the years after adoption of the DBR are not only counted and included in the estimation of the polynomial terms for Luzern and St. Gallen, but for all cantons that have switched from the LBR to the DBR in the 20th century. Now Schaffhausen (DBR in 1921), Solothurn (DBR in 1932), Thurgau (DBR in 1930) and Zurich (DBR in 1929) are included in the treatment group.

Note that these cantons have made the institutional transitions before we start observing the data in 1933. Therefore, the estimation of the DBR Dummy is essen-

[28]The F-statistic for joint significance of the four polynomial terms amounts to 36.78 and the null can be rejected at all conventional levels of significance.

Table 4.4: Without Cantons where Roe Deer is not the most important Big Game

	(1)	(2)	(3)
DBR Dummy	2.020*		
	(0.011)		
Linear Term		0.0739**	-0.0599
		(0.003)	(0.383)
Quadratic Term			0.0110*
			(0.022)
Cubic Term			-0.000291**
			(0.006)
4th Order Term			0.00000240**
			(0.002)
N	1189	1189	1189

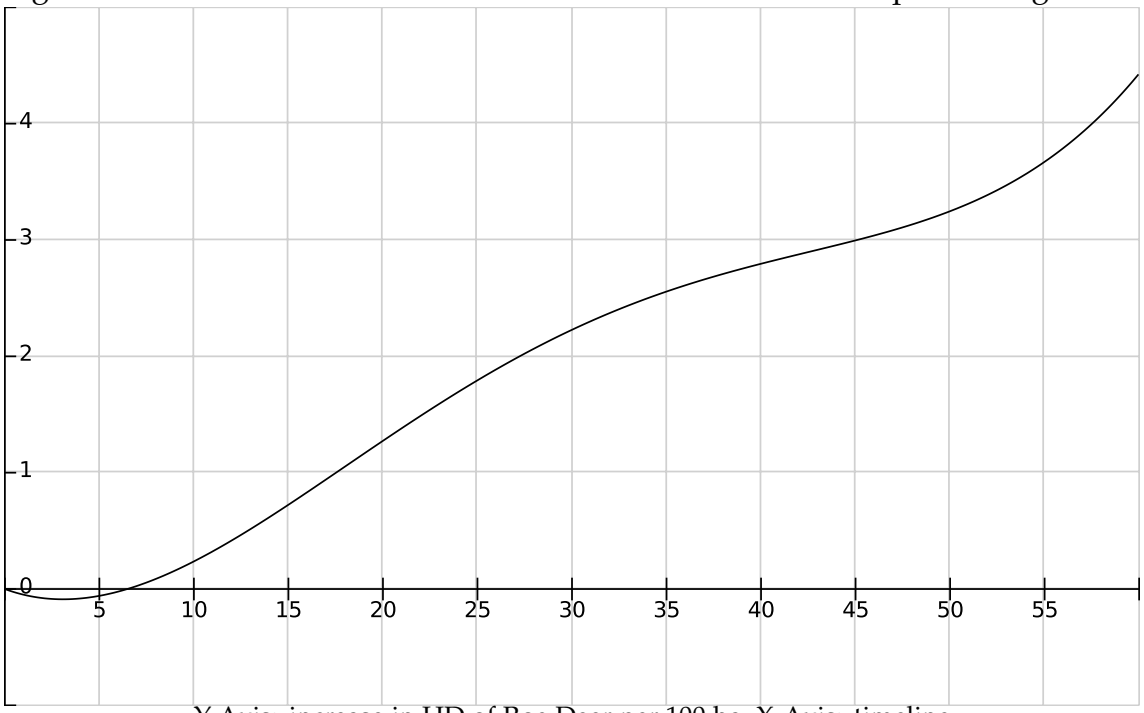
p-values in parentheses
with cantonal FEs and full set of yearly TDs, SEs clustered for cantons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

tially the same as testing it for the baseline specification, as the DBR characteristic for the early adopters is picked up by the cantonal fixed effect. Moreover, column 2 shows that the linear trend for the treated group is not significantly different from zero at conventional levels of significance. As for the other results, polynomials up to the 6th degree were estimated to allow for different kinds of non-linearities. In the third column the results are presented for a 4th order polynomial[29], for which you find a graph in black in Figure 4.11. In the fourth column you find the results for a 5th order polynomial[30], the corresponding graph is blue in Figure 4.11. The graph for the 5th order polynomial exhibits slightly different dynamics compared to the previously presented 4th order polynomials. Still, they share the qualitative characteristics that were predicted by the theory: HDs of Roe Deer rise with a time lag after the introduction of the DBR. Over the course of 50 years, for the 5th order polynomial the results are again in the ballpark of what the previous

[29]The F-statistic for joint significance of the four polynomial terms amounts to 1.95 and the null cannot be rejected at conventional levels of significance (corresponding p-Value:0.1365).

[30]The F-statistic for joint significance of the four polynomial terms amounts to 5.71 and the null can be rejected at all conventional levels of significance (corresponding p-Value: 0.0024).

Figure 4.10: Without Cantons where Roe Deer is not the most important Big Game



Y-Axis: increase in HD of Roe Deer per 100 ha, X-Axis: timeline in years.

specifications had suggested: per 100ha of forested land, the HD of Roe Deer increases by 3-4 over a period of 50 years, for the 4th order polynomial the results are about a third smaller. One possible explanation for the shifting functional form could be given by the data structure: For the early years of treatment we still have very few observations, for the first year only St. Gallen and Luzern, but from the thirteenth year onwards, the number of cantons has risen to six and the estimator attributes weight to fitting these observations accordingly, giving more weight to a fit for the later treatment years. Moreover, right after the introduction of the Federal Hunting Statistic in 1933, data is still missing for some cantons and the data quality is probably relatively poor compared to later periods.[31]

4.5 Conclusion

This paper finds that the introduction of the DBR has had a positive effect on Roe Deer densities compared to the LBR. This finding is in line with theoretical

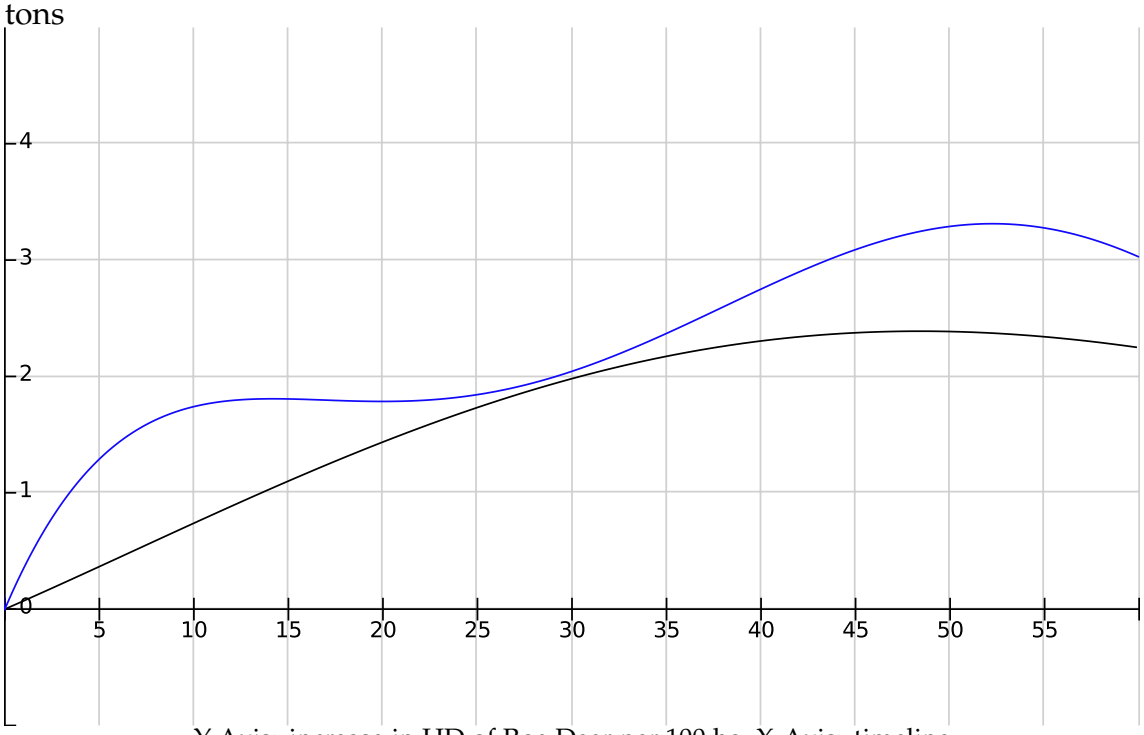
[31] If, for example, the incidence of missing observations can be taken as an indicator for poor data quality and heterogeneity in measurement efforts among cantonal authorities at the beginning of the period of observations.

Table 4.5: All 20th Century DBR Cantons

	(1)	(2)	(3)	(4)
DBR Dummy	2.200**			
	(0.002)			
Linear Term		0.0242	0.0711	0.381**
		(0.190)	(0.339)	(0.002)
Quadratic Term			0.000563	-0.0292*
			(0.851)	(0.019)
Cubic Term			-0.0000300	0.000980*
			(0.583)	(0.024)
4th Order Term			0.000000188	-0.0000139*
			(0.571)	(0.026)
5th Order Term				6.91e-08*
				(0.027)
N	1695	1695	1695	1695

p-values in parentheses
with Cantonal FEs and full set of yearly TDs, SEs clustered for cantons
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 4.11: Fourth and Fifth Order Polynomial with all 20th Century DBR Cantons



Y-Axis: increase in HD of Roe Deer per 100 ha, X-Axis: timeline in years.
Black: fourth order polynomial, Blue: fifth order polynomial

predictions from the institutional economics of renewable resources, which hold that the institution of private or common property gives incentives to the owners of the resource to use it such that the harvest in the current period is balanced against the increases in the asset value of the resource that materialize, if the stock of the resource grows. As such, this finding is closely related to the empirical literature on institutions of fisheries management. These results are commensurate with the interpretation, that giving ownership to individuals or groups under the DBR provides effective incentives to preserve a renewable resource in the long run.

As for possible extensions of this research project, a natural question to ask would be: what about the other big game species? The choice of Roe Deer as an indicator species that may exhibit such population dynamics after treatment was, among other reasons, justified by the small homeranges, that typically lie within a hunting district in a Swiss DBR canton. For other species, like Red Deer, Chamois and Wild Boar, that have larger home ranges and are more mobile, the effects of these two hunting institutions has not yet been examined. Preliminary

explorations, that are not presented here, have not shown equivalent results. Another obvious extension of this work would be to examine at a more detailed level how more specific hunting regulations differ in Swiss cantons with respect to certain game species and to explore the effects, wherever data is available, also at lower levels of aggregation.

Note, that in the case of game populations a higher stock is not necessarily better from a social welfare perspective: increased game populations can also lead to higher damages in agriculture and forestry. Therefore, such an increase in the stock of game must not be beneficial in the aggregate. Roe Deer, Red Deer and Wild Boar are notorious among farmers and foresters for their negative externalities. Therefore, this paper does not advocate the adoption of either the DBR or the LBR, but highlights how these two fundamentally different hunting institutions have led to large differences in population stocks per 100 ha of forested land depending on the choice of the regime for Roe Deer.

Thus, this project provides statistical evidence for the effective difference between the two institutions. A policy recommendation based on this evidence could be to adopt DBR-style regulations for species that should be preserved or even increased and to adopt LBR-style regulations for species for which the population growth should be held in check or for which a reduction in the stock would be favorable to social welfare. From the perspective of the hunting community, the DBR exhibits a clear advantage over the LBR with respect to a game species like Roe Deer in 20th century Switzerland, because the larger stock allows for a higher sustainable yield of harvested Roe Deer.[32]

[32]It is in order to point out, that cantonal DBR-regulations prescribe that the local hunters compensate, alleviate and manage various negative externalities that accrue to other interests in their district.

Appendix A

Appendix to "Long Run Effect of French Annexation on 19th Century Switzerland"

A.1 Quotation from Friedrich Engels' *"Die deutsche Reichsverfassungskampagne"*

Rheinpreußen hat seit 1815 als eine der fortgeschrittensten Provinzen Deutschlands gegolten, und mit Recht. Es vereinigt zwei Vorzüge, die sich in keinem andern Teil Deutschlands vereinigt finden.

Rheinpreußen teilt mit Luxemburg, Rheinhessen und der Pfalz den Vorteil, seit 1795 die Französische Revolution und die gesellschaftliche, administrative und legislative Konsolidierung ihrer Resultate unter Napoleon mitgemacht zu haben. Als die revolutionäre Partei in Paris erlag, trugen die Armeen die Revolution über die Grenzen. Vor diesen kaum befreiten Bauernsöhnen zerstoben nicht nur die Armeen des Heiligen Römischen Reichs, sondern auch die Feudalherrschaft des Adels und der Pfaffen. Seit zwei Generationen kennt das linke Rheinufer keinen Feudalismus mehr; der Adlige ist seiner Privilegien beraubt, der Grundbesitz ist aus seinen Händen und denen der Kirche in die Hände des Bauern übergegangen; der Boden ist parzelliert, der Bauer ist freier Grundbesitzer wie in Frankreich. In den Städten verschwanden die Zünfte und die patriarchalische Patrizierherrschaft zehn Jahre früher als irgendwo in Deutschland vor der freien Konkur-

renz, und der Code Napoléon sanktionierte schließlich den ganzen veränderten Zustand in der Zusammenfassung der gesamten revolutionären Institutionen.

Rheinpreußen besitzt aber zweitens - und darin liegt sein Hauptvorzug vor den übrigen Ländern des linken Rheinufers - die ausgebildetste und mannigfachste Industrie von ganz Deutschland. In den drei Regierungsbezirken Aachen, Köln und Düsseldorf sind fast alle Industriezweige vertreten: Baumwollen-, Wollen- und Seidenindustrie aller Art nebst den davon abhängigen Branchen der Bleicherei, Druckerei und Färberei, der Eisengießerei und Maschinenfabrikation, ferner Bergbau, Waffenschmieden und sonstige Metallindustrie finden sich hier auf dem Raum weniger Quadratmeilen konzentriert und beschäftigen eine Bevölkerung von in Deutschland unerhörter Dichtigkeit. An die Rheinprovinz schließt sich unmittelbar, sie mit einem Teil der Rohstoffe versorgend und industriell zu ihr gehörend, der märkische Eisen-und Kohlendistrikt an. Die beste Wasserstraße Deutschlands, die Nähe des Meeres, der mineralische Reichtum der Gegend begünstigen die Industrie, die außerdem zahlreiche Eisenbahnen erzeugt hat und ihr Eisenbahnnetz noch täglich vervollständigt. Mit der Industrie in Wechselwirkung steht ein für Deutschland sehr ausgedehnter Ausfuhr- und Einfuhrhandel nach allen Weltteilen, ein bedeutender direkter Verkehr mit allen großen Stapelplätzen des Weltmarkts und eine verhältnismäßige Spekulation in Rohprodukten und Eisenbahnaktien. Kurz, die industrielle und kommerzielle Entwicklungsstufe der Rheinprovinz ist, wenn auch auf dem Weltmarkt ziemlich unbedeutend, doch für Deutschland einzig.

Die Folge dieser - ebenfalls unter der revolutionären französischen Herrschaft aufgeblühten - Industrie und des mit ihr zusammenhängenden Handels in Rheinpreußen ist die Erzeugung einer mächtigen industriellen und kommerziellen großen Bourgeoisie und, im Gegensatz zu ihr, eines zahlreichen industriellen Proletariats, zweier Klassen, die im übrigen Deutschland nur sehr stellenweise und em-

bryonisch existieren, die aber die besondre politische Entwicklung der Rheinprovinz fast ausschließlich beherrschen.

Source: (Engels and Marx, 1960, p. 115-117)

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